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Electrical Welding. DR. PERRINE'S paper on electric welding ought certainly to afford encouragement to the exponents of that particular modern art. The process has proved enormously convenient for a very large number of purposes, particularly in small metal working, where the power required is not great and many welds have to be made. Wire working is facilitated in the most extraordinary way by the electric welder, for the joint so made is perfect—so perfect, indeed, that it cannot be found—and the welders in operation at the Roebling factory, where Dr. Perrine has had every opportunity to watch them, have shown a daily record of more than 1,000 welds in copper and iron wire. Every month seems to show new applications; perhaps the latest being one of which a capital example was shown at the meeting, the formation of projectiles by the welding process. The shells from modern rapid-fire guns have to be furnished with an intensely hard point for armor-piercing purposes, and up to a very recent date none except the smallest sizes have been successfully made in this country. It looks now, however, as if the electric welding process would come into play with excellent effect, for it is now possible cheaply and rapidly to furnish the steel body of the shell with a chrome steel point that is all that can be desired.

The Measurement of Alternating Potentials. PROF. MOLER'S brief paper on the method of accomplishing this particular measurement is worth studying. It seems rather surprising at first that estimates of luminosity can give the voltage as closely as the tests reported seem to show. However, it may be considered a little doubtful whether such good results could be obtained by every observer. The alternating current as met in everyday practice is a very annoying, exasperating thing to measure, and every suggestion of a new method will be kindly received. It is possible that Prof. Moler's plan might be made considerably more useful, so far as sensitiveness is concerned, by the simple device of balancing two lights, one on each circuit, against each other, and then shifting the connections by a double commutator, so that the alternating lamp should become the direct current one, and vice versa. It is probable that this arrangement would allow somewhat more accurate readings than the original one, and in so far it would be more effective as a means of calibrating alternating current voltmeters and the like. One convenience of this optical process is that it may be used in laboratories and testing-rooms where no properly calibrated alternating current apparatus is available and it is desired to construct it for temporary use.

The Fluctuations in Open-Coil Armatures. ONE of the neat pieces of work presented at the Institute meeting was Mr. Thompson's study of the extraordinary fluctuations that go on in the electromotive force produced by arc light machines of the ordinary open-coil type. It is obvious enough from the construction that the variations must be very great, and it is somewhat singular that their actual character has not been the object of study long before this. The particular dynamo investigated was an ordinary 10-light arc machine giving a current of 6.8 ampères. The fluctuations found at the terminals of the machine as ordinarily connected were marked, but not as violent as would have been anticipated. On a normal electromotive force of 500 volts the total fluctuation of the electromotive force amounted to nearly 100, with a corresponding momentary variation in the current. The author of the paper, however, went further and investigated the variations that take place in a single coil during a rotation. These proved to be most astonishing in violence, involving even powerful though momentary reversals of potential six times in each revolution. The average effect, however, as displayed at the terminals of the dynamo when running in the usual way are decidedly less than would at first be expected from the construction employed.

High Frequency Experiments. PERHAPS the most interesting feature of the meeting of the Institute of Electrical Engineers was Mr. Tesla's brilliant experimental lecture. Much had been heard of the remarkable experiments that had been performed in his laboratory, and it was with great interest that every one watched their progress as the inventor showed them Wednesday night. They represented a class of phenomena depending on enormous static fields produced by a generator of high potential and giving exceedingly great frequency. The effects obtained, then, were due very largely to condenser action in a field of quite unique power. Many of Mr. Tesla's results have been hinted at by previous experimenters using other apparatus, but some of them were absolutely new and all were enormously more imposing in degree than have ever previously been produced. Just how far luminosity produced by electrostatic action can be made practical it is difficult to say; the problem is certainly in good hands, and Mr. Tesla has already obtained results more encouraging than those made public in his lecture. Certain it is that the tendency of his experiments is to greatly widen our view of electrical phenomena. As to practical applications, however, the difficulties that must be met are somewhat formidable and of rather unusual character. An electrical condenser would make a magnificent transforming device for general purposes could it be cheaply constructed with a sufficiently good dielectric. Mr. Tesla gave some little account of the trouble given him by the ordinary insulating materials under the conditions of his work, and it is only too evident that condensers as heretofore made are unsatisfactory for the very severe service that would be required of them. For use for such currents an insulating material must be possessed of very remarkable qualities, as was most beautifully shown in one of the experiments at the lecture; a discharge at the enormous frequency employed passed through glass with the greatest readiness, not by sparking, as is the case with a single discharge from an inductorium or static machine, but by a steady transference. It is probable that the best dielectric for such work may be quite outside the range of those most familiar to us, and perhaps complete homogeneousness would be the most valuable physical property under the circumstances. We postpone a detailed discussion of Mr. Tesla's beautiful experiments until the publication of his paper in full a week hence. For the present it will be sufficient to say that it was one of the most brilliant and fascinating lectures that it has ever been our fortune to attend.

Architecture at all Hazards. IT is unfortunately reported from Chicago that the plans for a united electrical exhibit have been frustrated in spite of the earnest efforts of Mr. J. P. Barrett to consolidate all the electrical displays under one roof. As it is, the exhibit will be in two portions some 1,500 feet apart. The reason for this unfortunate arrangement may be sought in the inner consciousness of the construction department and its architects. The question of inward fitness for the purposes designed seems one that seldom or never enters into the understanding or the calculations of an architect. If a splendid exterior and harmonious outward proportions can reflect lustre on his artistic skill, any purposes for which the building might possibly be employed seem to be completely forgotten. Not long ago, while a fine laboratory was building for one of our institutions of learning, a violent dispute arose between the head of the department for which the laboratory was intended and the architect; the former demanding windows, inasmuch as the building was to be used for purposes of instruction; the party of the second part insisting on fewer windows and those of mediæval dimensions, in order that the harmonies of the structure might not be destroyed and his architectural reputation imperilled. It was Greek against Greek for awhile, and then common sense prevailed and the windows went in. In Chicago, however, the result of a similar contest has been less satisfactory. The buildings were laid out in dismal ignorance or utter unconcern of the real needs of the various departments for whose uses said buildings were intended; and, once planned, the symmetry of the whole must, forsooth, be preserved, whatever the effect on the exhibits supposed by the vulgar populace to be a somewhat interesting part of the World's Columbian Exposition. It is hard on the electrical section; but the majesty of art has perhaps been preserved against the envious hand of practical common sense.

Aluminium and Its Name. THE aluminium question received pretty full discussion at the recent meeting of the Institute of Electrical Engineers. In the first place, Dr. Wahl's paper, which is unfortunately delayed by undergoing revision at the hands of its author, excited the electrical aluminium contingent by presenting the possibilities of a chemical process for its extraction. In the next place, a well-meant, but somewhat ill-advised, attempt was made to recommend the coining of a new name for the metal in question. In addition to this we publish on another page a communication from Mr. Hall, the inventor of the aluminium process used by the Pittsburgh Reduction Company, protesting against some of Prof. Crocker's statements about the metal in the discussion at the previous meeting of the Institute. Altogether aluminium is prominently before us. Now, in the first place, as regards the methods for extracting it, electricity is at present very much ahead, and, to all appearances, quite likely to stay there. As touching aluminium itself in its practical applications, there is more of doubt. No amount of enthusiasm or juggling with figures can make pure aluminium anything but a rather soft metal of low tensile strength. It further possesses the very undesirable quality of softening considerably at a point below its melting point, and melting quite easily at that. For purposes requiring strength the pure metal is undesirable. Prof. Crocker was quite right, then, in saying that so far as pure aluminium is concerned it is rather impracticable. This, however, is not abuse of aluminium by any means, because in its alloys it undoubtedly is exceedingly useful; the alloy with silver is admirable, and that with a small percentage of copper may turn out to be nearly as good. For domestic uses, such as cooking utensils, forks, spoons, and the like, aluminium possesses some excellent qualities, and others that are far from being excellent. It is not attacked very readily by most acids; it is attacked with great violence by hydrochloric acid and caustics. Organic acids, as a rule, do not affect it enough to constitute a serious objection to its use for cooking purposes, especially as its salts are comparatively harmless. The metal itself, however, has somewhat of a metallic taste, and is not entirely free from odor when in use, unless very pure. So it behooves the friends of the metal to see to it that the commercial product be free from this particular objection. As regards its name, it is hard to see any reason for changing it from its original form of aluminium. The language has suffered enough already from new and unnecessary terms. If we insist on shortening aluminium to "alium," why should we not also shorten potassium to "pot," and copper to "cop"? The reasons for such changes would be equally plausible, for if it is a merit to shorten a five-syllable word to three, it certainly is an even greater virtue to shorten a four-syllable word to one. It is to be hoped that we may be spared the affliction of an electrical dialect.

Latest Foreign Electrical News.

(By cable from our regular correspondent.)

LONDON, May 25, 1891.—The last meeting of the Institution of Electrical Engineers was a session devoted to discussion. As might have been expected, Dr. J. A. Fleming's paper on the Ferranti effect stirred up a vigorous debate, for ever since the curious phenomena of rise of potential were discovered in the Deptford mains, the rationale of the occurrence has been the subject of much theorizing on the part of many of the best known engineers. The speakers in this discussion were Major Cardew, who has long been connected with the Ferranti system, and who is perhaps best known to Americans as the inventor of the Cardew voltmeter; Prof. Sumpner; Mr. Blakesley, author of an admirable little book on alternating currents; Mr. James Swinburne, who has had much to say on this topic before; and, finally, Mr. Siemens, head of the well-known English firm, who announced that the result of some experiments showed that the Ferranti effect was considerably modified by the shape of the transformer employed on the circuit; in one instance that fell under his observation a total disappearance of the distortion change in the induced effects was noted. Next in the order of discussion came Mr. W. H. Preece's paper on electric lighting mains, and Mr. Crompton's paper on low-pressure distribution of current. The speakers in this debate were Mr. G. L. Addenbrooke, Gen. C. E. Webber, Mr. Gisbert Kapp, Messrs. Swinburne, Maver and Siemens. Mr. Crompton's claims for superior economy in the system of low-pressure distribution were attacked vigorously; but Sir William Thomson, who was present, in summing up the matter spoke strongly in favor of the low-pressure system, and thought that eccentric stations were a mistake in engineering practice.

On Friday evening Professor Ewing gave an admirable discourse before the Royal Institution on the "Molecular Theory of Magnetism." He spoke with great appreciation of Mr. Hoopes' research on this subject with models of molecular magnets, described in THE ELECTRICAL WORLD that reached England that morning, and the curves from this paper were thrown on the screen amid great applause.

The City and South London Railway has introduced something of an innovation by running workmen's trains during the early morning hours at a penny fare, just half the usual rate.

Moonlight Tables for June, 1891.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of June, under his modified form of moon schedule.

TABLE NO. 1.
Standard Moonlight, Philadelphia System.

Date.	Light.	Date.	Exting.
1	7:50 P.M.	2	3:10 A.M.
2	7:50	3	3:30
3	7:55	4	3:30
4	7:55	5	3:30
5	7:55	6	3:30
6	7:55	7	3:30
7	7:55	8	3:30
8	7:55	9	3:30
9	7:55	10	3:30
10	7:55	11	3:30
11	10:40	12	3:30
12	11:05	13	3:30
13	11:30	14	3:30
14	11:50	15	3:30
15			
16	12:15 A.M.	16	3:30
17	12:35	17	3:30
18	1:09	18	3:30
19	1:30	19	3:30
20	2:05	20	3:30
21	No light.	21	No light.
22	No light.	22	No light.
23	No light.	23	No light.
24	8:00 P.M.	24	11:10 P.M.
25	8:00	25	11:50
26	8:00	27	12:20 A.M.
27	8:00	28	12:50
28	8:00	29	1:15
29	8:00	30	1:40
30	8:00	1	2:10

Total hours lighting, 137.55.

TABLE NO. 2
Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	7:50 P.M.	2	3:10 A.M.
2	7:50	3	3:30
3	7:55	4	3:30
4	7:55	5	3:30
5	7:55	6	3:30
6	7:55	7	3:30
7	7:55	8	3:30
8	7:55	9	3:30
9	7:55	10	3:30
10	7:55	11	3:30
11	7:55	12	3:30
12	7:55	13	3:30
13	7:55	14	3:30
14	7:55	15	3:30
15	7:55	16	3:30 A.M.
16	8:00 P.M.	16	12:00 M.
17	12:35 A.M.	17	3:30 A.M.
17	8:00 P.M.	17	12:00 M.
18	1:00 A.M.	18	3:30 A.M.
18	8:00 P.M.	18	12:00 M.
19	8:00	19	12:00
20	8:00	20	12:00
21	8:00	21	12:00
22	8:00	22	12:00
23	8:00	23	12:00
24	8:00	24	12:00
25	8:00	25	12:00
26	8:00	27	12:20 A.M.
27	8:00	28	1:50 A.M.
28	8:00	29	1:15
29	8:00	30	1:40
30	8:00	1	2:10

Total hours lighting, 185.15.

NEW BOOKS.

PRACTICAL ELECTRICAL ENGINEERING. By W. W. Beaumont, C. W. H. Biggs, C. Capito, G. Kapp, A. Reckenzaun, P. Sellon, J. Swinburne and H. Swan. Parts IV., V. and VI. Biggs & Co., London, 1891. Price, 75 cents each.

These three sections of this agglomerative work, of which we have previously made mention, are principally devoted to steam engineering in pursuance of the plan of campaign followed in the compilation of the work. Part IV. continues the discussion of steam boilers begun in Part III., and closes it with a somewhat lengthy discussion of steam pipes, valves and other subsidiary apparatus. Chapter IX., just at the end of Part IV., takes up the subject of the general principles of dynamics, and, after treating it somewhat briefly as a preface to the subject of thermodynamics, takes up formally the study of heat. This is treated in a manner somewhat condensed and mathematical, and is followed by the theory of steam engines, which is singularly taken up before the details of their construction are brought before the reader's notice. The discussion of the engine, like that of the general subject of heat, is somewhat painfully mathematical for a popular treatise, but it is redeemed by a very practical discussion of the indicator and its uses, perhaps the most useful part of this section of the work. The discussion of the steam engine is continued into Part VI., which contains a very brief chapter on the practical details of engines. Through the remainder of Part VI. the subject discussed are switches and switchboards, and these subjects are elucidated by numerous cuts and diagrams of switchboards for various sorts of uses. Part VI. concludes with an explanation of some of the dynamical considerations that enter into the subject of electrical measurements.

The Annual Meeting of the American Institute of Electrical Engineers.

The annual meeting of the Institute held last week was certainly one of the most successful in the history of the organization. The attendance was good and the papers were of unusual merit. Of course, business before pleasure holds with electricians as with other people, and the first meeting of the Institute on Tuesday evening, May 19, was devoted to the annual election and to the routine business necessary. A nominating committee was appointed, and soon returned with the nominations for president, vice-presidents and managers. The nomination for president was received with enthusiasm, and it would indeed be difficult to find one on whom the honor could more fittingly be bestowed than on Alexander Graham Bell, the inventor of the telephone. The vice-presidents chosen were Mr. T. D. Lockwood, Mr. O. T. Crosby, Mr. Carl Hering and Mr. W. J. Hammer. On the opposite page we present to the readers of THE ELECTRICAL WORLD the portraits of these newly elected officers of the Institute, with a few notes with reference to their respective careers; for, although these are familiar to their fellow-members of the Institute, the electrical public can well be reminded of what some of them have done for electrical science. Three vice-presidents held over from last year, as did all but four of the board of managers. The new managers elected were Dr. Louis Bell, Mr. Herbert L. Webb, Prof. Alfred G. Compton, and Mr. James Hamblet. After the election the routine business of the meeting was taken up, the reports of officers listened to, and similar business transacted. The attendance at this preliminary meeting was comparatively small, most of the out-of-town members not having arrived. Wednesday morning the real business of the annual meeting began. The meeting was called to order rather late, as usual, for the members appeared somewhat late, and it was nearly 11 o'clock when the first paper on the perfection of the stationary electric motor, by Prof. F. B. Crocker, was taken up. In this paper was discussed the design of electric motors, particularly with reference to the characteristic motor type which the author with Dr. S. S. Wheeler had developed during the past few years. The questions taken up systematically covered the general principles of design, the form of base, of magnetic circuit, of field coils, and the proper construction of the armature.

Prof. Crocker, as will be guessed by any one who has seen his motors, is an advocate of toothed armatures, and his exposition of their merits was decidedly interesting. The account of the working out of various mechanical details of the construction of the modern motor was exceedingly instructive, and the paper led to a discussion particularly rich in practical points concerning the theory and practice of motor design. In fact, the discussion was so extended and interesting that it protracted itself until the hour when it became appropriate for the morning session to adjourn, and the members, therefore, without hearing any further papers, went to lunch.

An elegant collation had been provided by the Institute under the direction of Mr. Stadler, the steward of the New York Electric Club, and after discussing this and other topics very enthusiastically the meeting formally reassembled a little after two o'clock, and took up the next paper of the day, which was read by Dr. E. L. Nichols, on the photographic study of the electric arc. Dr. Nichols dealt especially with the study of the alternations in luminosity found in the alternating arc. The method was that of photographing the arc on a very rapidly moving plate, the result being a band of periodic variations in brightness, and, under certain circumstances, with evidences of complete extinction of light during a short period. The contrast between the continuous and alternating arcs is made very obvious by this method of study.

The photographs were supplemented during the research by eye observations taken by the well-known method of viewing the arc as reflected from a very rapidly revolving mirror. In the subsequent discussion Prof. Elihu Thomson supplemented the paper by a number of interesting suggestions regarding the interpretation of the evidence in the case of the alternating arc. Some of the photographs showed a disintegrating effect of the arc very clearly, bits of incandescent carbon shot off from it leaving distinct traces on the plates. A little latter Mr. Carl Hering's paper on a graphical method of calculating wire was read, and proved to be substantially a full explanation of a graphical device recently published by him in his little work on the computation of wiring. A number of graphical methods have been devised from time to time, and Dr. F. A. C. Perrine contributed a particularly beautiful one, which he had never published before, but which proved to be remarkable for its simplicity.

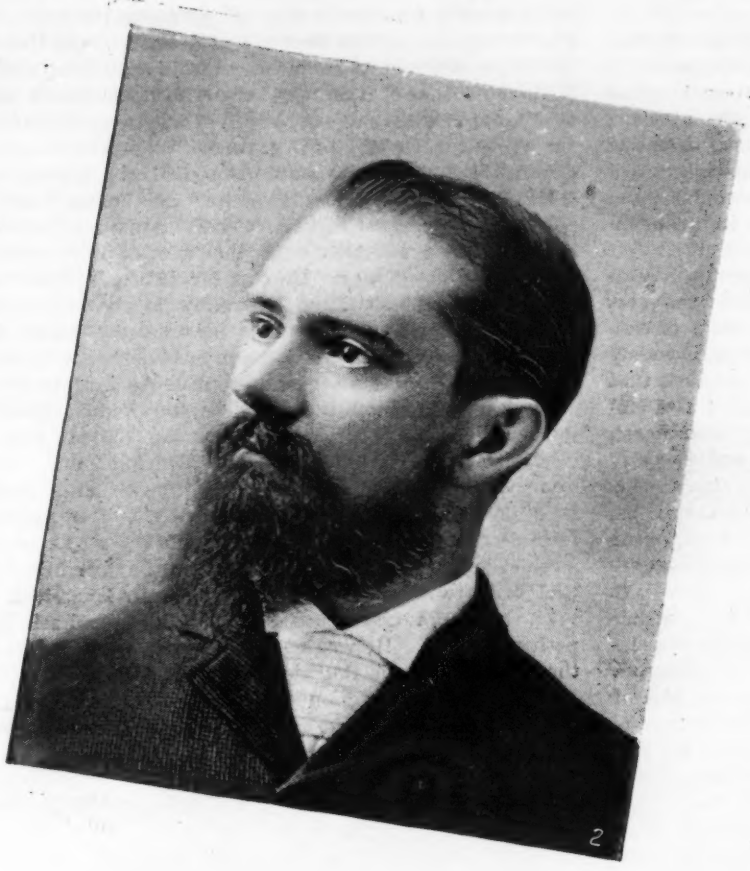
Dr. Perrine is the electrician of the Roebling works, and, after the close of the discussion on Mr. Hering's paper, gave some results of the practical application of electric welding, especially with reference to its employment in wire factories. Some beautiful examples of welding were at hand, and the practical points were extremely interesting. The welding done at the Roebling works is, of course, principally of iron, steel and copper, but Dr. Perrine went on to give a very useful description of all sorts of applications of electric welding on a scale much larger than that employed in wire work. To the discussion of this Prof. Thomson contributed some exceedingly clever and valuable suggestions. This terminated the afternoon session, for the hour was then so late that Mr. Sprague's paper was put off until the morning, and the meeting adjourned, to meet again at Columbia College to listen to a lecture by Mr. Nikola Tesla on his experiments with alternating currents of high frequency. Mr. Tesla's first paper on this subject was published in THE ELECTRICAL WORLD a short time since, and the experiments he showed were in part those there described. During a long period of research on this subject Mr. Tesla has built a considerable number of machines, but, owing to unfortunate accidents, only one happened to be in full working order at the time. This survivor was put in operation in the dynamo-room of Columbia College. It consisted of a ring with 400 internally projecting poles, a disc armature, with corresponding field coils running just inside of it; the rotative speed was necessarily very high to obtain the frequencies desired, but the machine ran with perfect steadiness throughout the evening. It was, fortunately, some little distance from the lecture room, for the noise produced by the flying armature was little short of terrific. The experiments showed in a most striking way the beautiful effects that can be obtained with the combination of high electromotive force with almost transcendental frequencies; as high as 20,000 periods per second were employed, and the static effects were prodigious. Geissler tubes glowed when anywhere in the vicinity of the induction coils, to which currents from the dynamo were led, and glow lamps entirely disconnected from the terminals could be brought to bright incandescence.

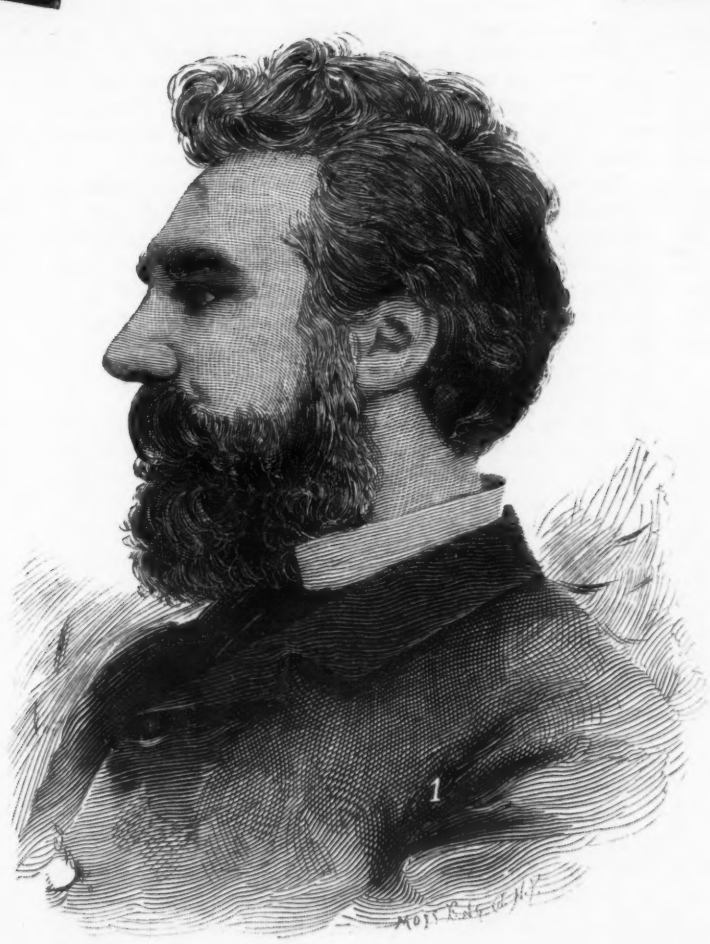
Perhaps the most striking, from a pyrotechnic point of view, of these experiments was the lighting up of two great Geissler tubes stretched out by the experimenter in either hand in the midst of a powerful field formed between the terminal of an induction coil and a large zinc plate that hung on the lecturer's right. Mr. Tesla prefaced his remarks by an exceedingly suggestive little discussion of some modern electrical theories, and especially the phases of electrical science that had led him into this particular field of research, that may some time be richly productive of practical results. Mr. Tesla held his audience to the closest attention from half-past eight until nearly midnight. Many of the experiments were unique, and all of them, even those which can be at least suggested by the use of ordinary apparatus, showed the enormous effects of the frequencies employed.

The next morning a visit to the Crocker-Wheeler motor factory, which was thrown open for inspection, engrossed the attention of most of the members present during the early morning; and about 11 o'clock they had straggled back to headquarters, and the work of the morning session was taken up.

The first subject to claim attention was Prof. George S. Moler's description of a method of measuring the potential of alternating currents. Exact means for this particular measurement have been none too common, and the instrument described was intended to be used mainly for calibrating alternating current voltmeters. The principal employed was the use of an incandescent lamp as an indicator, it being put first upon the alternating current, and then brought to the same light intensity by a direct current, the potential of which can be easily measured. The equivalent voltage of the alternating current is thus ascertained with great accuracy. The result showed that the adjustment of the light could be made to within .1 of a volt, quite close enough for practical purposes.

Mr. F. J. Sprague then read his paper on the rapid transit problem in New York. It was not what might have been expected from its original title as published in the announcements, but was rather a very clear and able treatment of the present status of the problem, the conditions that must be fulfilled by any system that will prove satisfactory, and a brief description of the possibilities of the various plans suggested, treated not in detail but as representing various types of construction. No more pertinent subject could have been brought before the meeting, and when Mr. Sprague closed after a strong presentation of the necessity for electrical power in any successful system, the Institute was gratified by hearing from Prof. Geo. Forbes, who fortunately happened to be at this meeting, an account of the success that had been attained with electric underground traction on the City & South London Railway. If any of the audience were unconvinced by Mr. Sprague's paper, Prof. Forbes' statements left their doubts no room to stand upon.





2. THOS. D. LOCKWOOD. 4. ICARL IHERING. 1. ALEX. GRAHAM BELL. 3. O. IT. CROSBY. 5. W.EJ. HAMMER.

This paper ended, Mr. G. W. Walker read a somewhat extended discussion of the often-raised question of the possibilities of the electric meter, with special reference to some of the forms now employed. Mr. Walker, who is himself the inventor of a very neat and accurate photographic registering meter, paid his respects to the Thomson watt meter in a way that brought its inventor, who was present, to his feet in self-defence. Mr. Edward Weston took an active hand in the discussion, and during its course a great many practical suggestions on all sides of the question were made.

After an hour's recess another paper from Cornell University was brought before the meeting, being a study of the variations of the electromotive force in arc-light dynamos. A Thomson-Houston was the type discussed, and the results proved to be very curious, showing, as might have been expected from the peculiar connections of the machine, most violent variations and even momentary reversals of the potential. The method of measurement employed is similar to that which has been used for studying instantaneous potentials during various phases of an alternating current. A special commutator was used, consisting essentially of a tongue mounted on the shaft of the dynamo and making flying contact with a spring that could be rotated about the axis of the armature, thus giving the potentials at each point of the commutator.

Dr. W. H. Wahl then treated the aluminium problem, a topic which had been looked forward to by many of the members present. Two of the electrical aluminium smelting companies, the Cowles and the Pittsburgh Reduction Company, were present with samples of the metal, those of the latter company being particularly beautiful, as they consisted mainly of fancy articles and various utensils made from the pure metal and exquisitely polished.

Dr. Wahl's paper was regarded by some of these gentlemen as somewhat Philistinic in its character, for he boldly took the position that in the success of electrical smelting the chemical processes which first gave aluminium to the world had been rather overlooked and their development somewhat checked. He described very clearly and in admirable detail the modifications of Deville's beautiful process, which had been, or could be, made with a view by proper utilization of the by-products to reducing cost. In fact, he went so far as to make a comparison between the cost of chemical and electrical processes, with the result of showing that the chemical methods were able to hold their own under favorable conditions. This conclusion naturally provoked lively discussion, which faded into insignificance, however, beside the vigorous critiques bestowed on the final paper of the day, which was read by Mr. Oberlin Smith, and raised the question of changing the name of the metal that had previously been under discussion. He favored contracting aluminium to "alium"; but his views were emphatically not shared by most of the members present, and their comments were of so discouraging a character that there is little likelihood of such a change being received with favor, even though it shortens the name of the metal by two short syllables. This closed the regular work of the annual meeting, but its entertainment was continued in the evening by a very pleasant reception courteously tendered by the Electric Club to the Institute. A very large part of both organizations were present, and the occasion was most enjoyable, not the least of the attractions being the very fine collection of early electrical books, apparatus and models collected as a loan exhibition through the energetic efforts of the entertainment committee. This assemblage of objects of electrical interest would be hard to equal, for it contained not only books of the most rare and interesting description, but apparatus of great historical value—the first electric fixture ever made in the country, many of the early incandescent lamps, the first transformer and many other objects of unique importance. The reception extended far into the night and appropriately closed what has been beyond question a most valuable and interesting meeting.

Electromotive Force and Difference of Potential.

A correspondent of *The Electrician* (London) says on this subject: "In order to properly grasp the difference which physically exists between an electromotive force and a difference of potential, the following are two very simple and opposite examples which show very clearly this difference, and which are, I think, worth publication:

"If one considers a charged condenser, and we suppose that the battery which has charged it to be destroyed, then there exists between the two plates a *difference of potential*, although the electromotive force which has given rise to it has ceased to exist. If, on the other hand, we consider a transformer, the primary circuit of which is connected to an alternator, slightly excited so as not to burn the secondary circuit, which we will suppose is closed on itself on short circuit, then there exists in this secondary circuit a current, and consequently an *electromotive force* producing a current, but it is absolutely impossible to find the least difference of potential between two points in any part of the secondary circuit. These two cases establish very clearly the difference between these two physical quantities, since it is always possible to have the one without the other.

The Newly Elected Officers of the Institute.

Though the name of Alexander Graham Bell, the president of the American Institute of Electrical Engineers, is a household word at the present day, his career is not as widely known as it should be. In fact, there seems to exist an idea that he was one of the fortunate class of inventors who stumble on a great discovery. On the contrary, if there ever was a case in which life-long scientific training and hard work brought their reward it was in the invention of the telephone.

Alexander Graham Bell was born in Edinburgh, Scotland, on March 3, 1847. He comes of an educated family, his father and grandfather before him being teachers of language, and his father, Alexander Melville Bell, is widely known as the deviser of a system of visible speech that has proven a boon to deaf mutes. Alexander Graham Bell from his earliest boyhood was trained by his father in the theory of speech and vocal physiology, and as early as 1866 he began, in following up Helmholtz's experiments in sound synthesis, to attempt the electrical transmission of speech. In 1870 the family emigrated to Canada, and in 1871 the future inventor of the telephone went to Boston, at the request of the Boston school board, to carry on work with his father's system of visible speech. He remained in Boston pursuing his investigations until 1881, when he moved to Washington, where he now lives. He steadily followed up the idea of electrical transmission of sound with special reference to multiple telegraphy, a line of investigation which led him to the telephone. At that time electrical transmission of speech, was a subject that was in the air, and of the numerous investigators who were working upon it, Alexander Graham Bell was by all odds the best trained and the most thoroughly versed in the mechanism of human speech. It ought to be a cause for satisfaction to those who believe in the efficacy of thorough training that the greatest inventive prize of the century should fall not to the tyro or to an unskilled mechanic making a fortunate guess, but to one who earned it by years of study.

The story of the telephone is too well known to need repeating here. It was not until 1876 that the first successful transmission of speech over a genuine line was accomplished, although for months the inventor had clearly seen the way. Since the invention of the telephone Prof. Bell's work has steadily followed the same lines of investigation, and the best known result of his labors is the radiophone—that beautiful, though at present unpractical, method of telephoning with a beam of light instead of a wire.

Thomas D. Lockwood, one of the vice-presidents of the Institute, is a worthy representative of telephone interests, and is widely known to all who are familiar with that field of work. Like Prof. Bell, he is a native of Great Britain, was born there in 1848, and after a hard training as a mechanic in his youth he emigrated to Canada in 1865, where he learned the art of telegraphy. The next few years were spent in various occupations, until finally, in 1879, he joined his fortunes with the National Bell Telephone Company, which was a little later merged into the American Bell Telephone Company, and since then his labors in improving the art of telephony have been continuous. He is a charter member of the American Institute of Electrical Engineers, and has served as vice-president and manager.

O. T. Crosby, another of the recently elected vice-presidents, is best known as an expert in electrical traction. He comes of old New England stock, but was born about 30 years ago in Louisiana. He entered the United States Military Academy in 1878 and graduated second in rank in a large class. Mr. Crosby was then assigned to the engineering corps and stationed at Willett's Point in the torpedo service. After two years spent here he was sent to New Orleans, and for a couple of years was engaged in planning and executing works of improvement about the Mississippi River. About 1887 he resigned from the army and joined the Sprague Electric Railway and Motor Co., in time to take an active hand in the very beginning of electric railroading. He remained with that company as superintendent for two years and a half, and then undertook the magnificent scheme of rapid transit planned by the Weems Electric Railway Company. Owing to temporary suspension of work he resigned to take the position of Southern district manager of the Edison company, with headquarters at New Orleans, and after a brief sojourn there was appointed general manager of the railway department of the Thomson-Houston Company, a position in which he is at present working with his usual energy and activity. No engineer is better known or more widely versed in electric traction than Mr. Crosby, and his present position gives him an admirable chance to display his efficiency in that growing sphere.

Carl Hering, still another of the vice-presidents of the Institute, although still a young man, a little over 30, has gained a wide reputation as a general electrical expert. He is a graduate of the University of Pennsylvania, and after serving there as instructor, went abroad, and spent some time in the study of electrical engineering in the laboratories of Germany. In 1883 he was the commissioner of the Franklin Institute to the electrical exhibition in Vienna, and served on the jury of awards at that time. In 1884 he returned to this country to become an electrician for the Franklin Institute Exhibition in Philadelphia. Since that time he has been untiring in his application to general electrical engineering. For two years he had charge of a course on that subject at the University of Pennsylvania. In 1889 he was sent to Paris by the United States Government to report upon the exhibition there. He is the author of a number of well-known books and tables on electrical subjects, and is shortly to go abroad as the representative of The Electrical World at the great electrical exhibition at Frankfort-on-the-Main.

Mr. William J. Hammer, at present a consulting and supervising engineer, is especially well known for his long and intimate connection with the rise of incandescent lighting in this country. He was Mr. Edison's private assistant in the Menlo Park laboratory at the very beginning of the development of the incandescent lamp. In connection with Mr. E. H. Johnson he established the first station in the world for incandescent lighting as electrical engineer of the English Edison company, and superintended the elaborate Edison display at the Crystal Palace electrical exhibition in 1882. During the next two years he was chief electrician and engineer of the German Edison Company and introduced incandescent lighting in Berlin. For two years he served as chief inspector of the Edison Company, and represented that organization at the Franklin Institute Exposition in 1884, the Cincinnati Exposition of 1888, and the Paris Exposition of 1889. He was one of the three incorporators of the Sprague Electric Railway and Motor Company, and is well known in connection with the development of the phonograph. At present he is working as an engineer on his own account, and is actively engaged in electric lighting, as heretofore.

Altogether the Institute may well feel proud of its new officers.

The Attendance at the Institute Meetings.

Among the members who attended the annual and general meetings of the American Institute of Electrical Engineers during the week, were the following:

Prof. W. A. Anthony, Manchester, Conn.; P. H. Alexander, New York; Watson G. Anthony, Newark, N. J.; George F. Atwood, Orange, N. J.; Dr. Louis Bell, New York; E. V. Baillard, New York; Harold Binney, New York; E. T. Birdsall, New York; Chas. S. Bradley, Avon, N. Y.; Frederick Bedell, Montclair, N. J.; J. C. Bennett, New York; Chas. J. Bogue, New York; Edward C. Boynton, Brooklyn, N. Y.; Alex. S. Brown, Boonton, N. J.; Francis B. Crocker, New York; Edward Caldwell, New York; John S. Cobb, New York; Chas. L. Cornell, New York; W. F. D. Crane, Philadelphia, Pa.; Johannes H. Cuntz, Hoboken, N. J.; Holbrook Cushman, New York; Patrick Bernard Delany, South Orange, N. J.; Gano S. Dunn, New York; William Elmer, Jr., Princeton, N. J.; Wilfrid H. Fleming, Brooklyn, N. Y.; Horatio A. Foster, New York; Henry G. Fiske, New York; Allen R. Foote, Washington, D. C.; Dr. Wm. E. Geyer, Hoboken, N. J.; Walter A. Giles, Pittsburgh, Pa.; George C. Grower, Ansonia, Conn.; James Hamblet, New York; George A. Hamilton, New York; W. J. Hammer, Newark, N. J.; Charles Hewitt, New York; Carl Hering, Philadelphia, Pa.; Hermann S. Hering, Philadelphia, Pa.; John W. Howell, Harrison, N. J.; Edwin H. Hall, Cambridge, Mass.; Dr. Cary T. Hutchinson, New York; Frank E. Idell, New York; A. Langstaff Johnston, Richmond, Va.; W. J. Johnston, New York; F. R. Jones, Knoxville, Tenn.; H. Ward Leonard, New York; Louis H. Laudy, New York; Thos. D. Lockwood, Boston, Mass.; Osborn P. Loomis, Brooklyn, N. Y.; Robert T. Lozier, New York; C. O. Mailloux, New York; William Maver, Jr., New York; J. Martin, Newark, N. J.; T. Commerford Martin, New York; Dr. Otto A. Moses, New York; Edward L. Nichols, Ithaca, N. Y.; Arthur J. Newell, Holyoke, Mass.; H. A. Ockershausen, Jersey City, N. J.; Frederic A. C. Perrine, Trenton, N. J.; Franklin L. Pope, New York; Geo. B. Prescott, Jr., New York; Frank C. Perkins, Ithaca, N. Y.; Geo. M. Phelps, New York; Ralph W. Pope, New York; Frederick Reckenzaun, West Hoboken, N. J.; E. Wilbur Rice, Jr., Lynn, Mass.; Wm. A. Rosenbaum, New York; F. M. Rosenberg, New York; Luther Stieringer, New York; Frederick Saxelby, Harrison, N. J.; Frank J. Sprague, New York; William Stanley, Jr., Pittsfield, Mass.; Geo. H. Stockbridge, New York; M. C. Sullivan, New York; Henry N. Sweet, Boston, Mass.; Prof. Elihu Thomson, Lynn, Mass.; Edward P. Thompson, New York; Thos. R. Taltavall, New York; Nikola Tesla, New York; Wm. Boardman Tobey, Pittsfield, Mass.; Henry C. Townsend, New York; Geo. W. Tuttle, New York; Francis R. Upton, Harrison, N. J.; Richard Varley, Jr., Passaic, N. J.; C. Reginald Van Trump, Wilmington, Del.; Philip V. R. Van Wyck, Jr., New York; Dr. Leonard Waldo, Bridgeport, Conn.; Herbert Laws Webb, New York; Edward Weston, Newark, N. J.; Joseph Wetzler, New York; Schuyler S. Wheeler, New York; John Waring, Manchester, Conn.; J. G. White, New York; W. G. Whitmore, New York; J. P. Wintringham, New York; John D. Wright, Newark, N. J.; Gilbert Wilkes, New York.

Among the guests in attendance were: S. D. Mott, Passaic, N. J.; J. B. Taltavall, New York; W. T. Hunt, New York; Jas. A. Alden, Passaic, N. J.; M. E. Thompson, Ithaca, N. Y.; Fred. A. Bowman, New York; P. H. Vander Weyde, Brooklyn, N. Y.; J. M. Johnston, New York; F. H. Nalder, London, England; E. W. Stevenson, New York; Douglas Burnett, Brooklyn, N. Y.; W. L. Bliss, Brooklyn, N. Y.; H. Cochrane, Brooklyn, N. Y.; Elmer A. Sperry, Chicago, Ill.; Geo. W. Walker, Brooklyn, N. Y.; Stephen L. Coles, New York City; E. E. Bartlett, New York; D. E. Hervey, New York; W. H. Wahl, Philadelphia, Pa.; Oberlin Smith, Bridgeton, N. J.; Prof. Geo. Forbes, London, England.

The New Westinghouse Fan Motor.

During the last few years a number of electric fan motors have been introduced, and while some of them were tolerably fair ventilators, their operation, however, required a large amount of current, which made them so expensive that their general introduction for private use was never a success. The Westinghouse Electric and Manufacturing Company is now constructing fan motors which embody all the salient points required for an electric motor to be an economical and perfect ventilator. The device has been very thoroughly tested, and it has proved to have

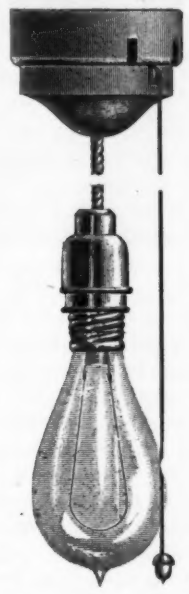
many advantages over the old style fan motors. It can be successfully used on an alternating current incandescent circuit. Attached to any ordinary lamp socket it will not use more current than one lamp. This is a point in its favor which will be readily appreciated by the private consumer, who pays for the electric current according to the amount registered by the meter. One of the motors was placed in one of the company's offices last November, where it has been running without interruption for six months. During all this time it has required no attention whatever, not even the application of a lubricant being necessary. The armature coils and the wires leading from the armature to the commutator are completely imbedded in a cementing material. This method of guarding the delicate parts of the apparatus precludes all danger of short-circuiting and it obviates any breaking of the wires by rough handling.

The speed of the Westinghouse fan motor can be varied in a very simple manner. The motor has two carbon brushes, which are set so as to feed automatically; at the same time they need not be renewed for years. A moving of these brushes to the left or the right regulates the speed. Apart from the usefulness of this little apparatus, it is highly ornamental. The fan is nickel-plated and the stand on which it is mounted is of brass. The fan motor can be carried about to any part of the room, as it only weighs about nine pounds.

THE WESTINGHOUSE FAN MOTOR.

A Combined Rosette and Snap Switch.

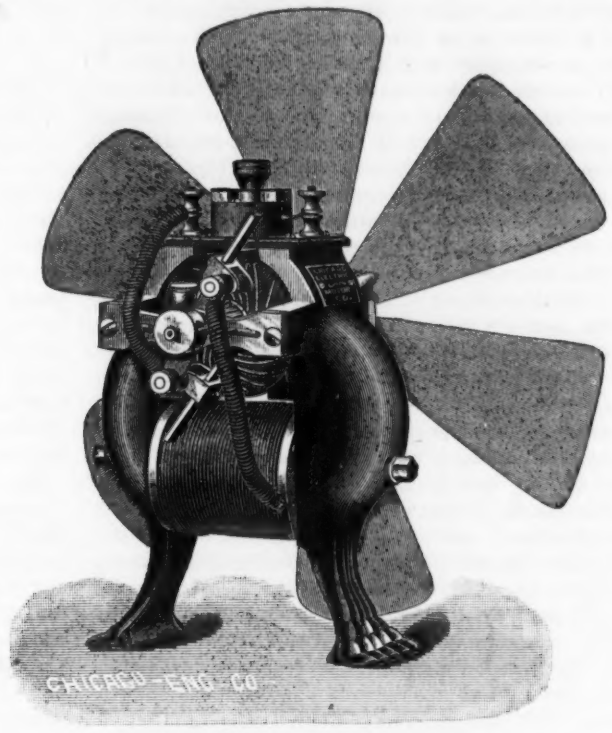
An ingenious combination of ceiling rosette and snap-switch is shown in the illustration. It combines all the ordinary features of a ceiling rosette with a device for switching the current on or off. A light silk or linen cord, with an ornamental tip, hangs within reach. The action is easy, without strain; one pull gives the current, the next turns it off. The cap is detachable, fastening with a twist lock, making a firm rubbing contact; it holds the fuse wires, switch, and the lamp cord terminals. In using the rosette the difference in cost between a key and a keyless socket is saved, and it is at the same time very convenient; the switch cord and tip are always in the same place. This combination is doubly useful where it is not desirable or possible to hang the lamp low enough to reach. It is the invention of Mr. Charles Wirt, and is made by The Electrical Supply Company, of Chicago. It is finished in hard wood and porcelain, suitable for cleat, molding or concealed wiring.



SNAP SWITCH AND CUT-OUT.

The Chicago Fan Motor.

The Chicago Electric Motor Company, of 207 Canal street, Chicago, Ill., has placed upon the market a new fan motor of a very neat and efficient design, as can be seen from the illustration. A single field coil is used and the general design is for strength with minimum size. A ring armature and stationary rocker-arms are used, and the terminals are neatly mounted on a fibre plate on the top of the pole pieces. The Chicago motor is wound for various pressures from 110 to 500 volts constant potential.



THE CHICAGO FAN MOTOR.

Small Slow-Speed Edison Motors.

The uses for small motors—that is, from $\frac{1}{16}$ h. p. to $\frac{1}{4}$ h. p., inclusive—are surprisingly numerous. Work formerly performed by hand is now often down by power, and every day some new application of the small electric motor is made. To meet the demand for motors of this class, the Edison General Electric Company has just placed upon the market a motor designed with special reference to its use in small sizes, and has aimed to embody in it all the essential features of a perfect motor, viz., minimum of attention and repair, efficiency, small first cost, slow speed and perfection of mechanical detail.

By connecting the coils of the armature with the commutator by German silver wires, the sparking which has often been found troublesome in small machines is reduced to a minimum. The motor has been so designed that no adjustment of the brushes whatever is required, the brush holders being fixed in position. Lubrication is accomplished by the use of grease instead of oil. As each coil of the armature is wound independently of the others, any coil can be replaced with great ease, and without disturbing any of the others. The bearings of the armature shaft consist of removable brass sleeves, which are adjusted to permit of perfect alignment. Upon the wearing of the brass bearings by continued use, they can be readily slipped out and new ones substituted.

The general arrangement of the motor is shown in Fig. 1. The armature revolves in a strong magnetic field, the lines of force being brought through the armature on both sides of the ring by means of specially shaped pole pieces made of the softest Norway iron.

The poles, shown in Fig. 2, are laminated to prevent heating, thus permitting the motor to run cool even when overloaded. These wrought iron pieces are attached to the magnetic frame, which at the same time forms the base upon which the machine is mounted.

The single field magnet coil is placed below the armature. This brings the centre of gravity down low, and adds to the steadiness and solidity of the machine.

The armature is built of soft laminated wrought iron, and is provided with teeth. The coils are placed in grooves between these teeth, which secure them firmly in position, and prevent any slipping of the wires.

The requirement of slow speed has been fully met and the motor rated at $\frac{1}{4}$ h. p. has been designed for a speed of 1,300 revolutions per minute. The machine is built in sizes from $\frac{1}{16}$ to $\frac{1}{4}$ h. p. The following table gives the various speeds and weights:

Type in H.P.	Rating in K. W.	Volts.	Speed.	Weight.
1/16	.050	125	2,200	14¾
1/8	.100	125	2,000	20¼
1/4	.200	125	1,300	28½
1/4	.400	125	1,500	37⅞

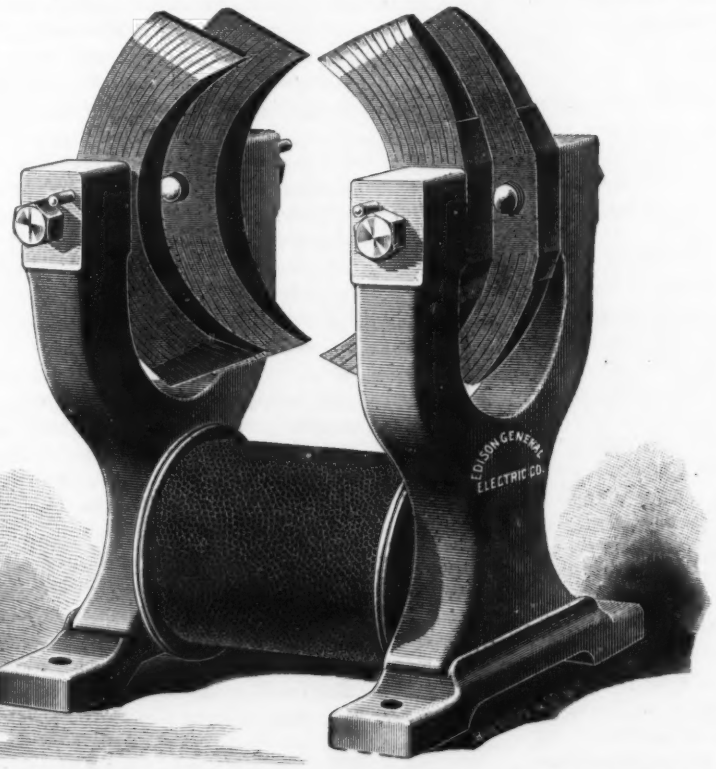


FIG. 2.—MAGNETIC CIRCUIT OF THE SMALL EDISON MOTOR.

FIG. 1.—GENERAL VIEW OF THE SMALL EDISON SLOW-SPEED MOTOR.

The Properties of Aluminium.

BY CHARLES M. HALL.

It was stated by Prof. F. B. Crocker in THE ELECTRICAL WORLD of May 16, in an article on the "Properties and Production of Aluminium," that 99 persons out of every 100 have entirely wrong ideas regarding that metal. This statement I am the more inclined to believe since reading Prof. Crocker's own article. His statements regarding the properties of aluminium are so wide of the mark and so misleading that they ought in the interests of sound information to be corrected. My reasons for undertaking to do this are that I have given a large part of the last five years to this subject, am largely interested in the production and sale of aluminium, and am familiar with its properties as shown by the experience of the past 30 years and by what is being done with it at present.

The main idea of Prof. Crocker's article seems to be that most of the supposed good qualities of aluminium really belong to its alloys and are wrongly attributed to the pure metal. This may be true to a certain extent in regard to the mechanical qualities of aluminium, but it shows a lamentable lack of information to say the same of its chemical qualities. Aluminium bronze of the best grade possesses 100,000 pounds tensile strength per square inch and correspondingly high elasticity. The saying that aluminium is as strong as steel may have arisen from confounding the strength of aluminium bronze with that of pure aluminium, or it might equally have arisen from what is the fact, that, comparing equal weights, aluminium is as strong as good specimens of steel. Thus the tensile strength of aluminium, 26,000 pounds, multiplied by three for difference in specific gravity, gives 78,000 pounds, whereas the best structural steel ranges from 60,000 to 70,000 pounds per square inch.

Again, Prof. Crocker says that aluminium has only one-third the strength of wrought iron. He must show a remarkable specimen of wrought iron with a tenacity of three times 26,000 pounds per square inch. The best quality of wrought iron runs from 48,000 to 50,000 pounds per square inch tenacity; so that aluminium has over one-half the strength of wrought iron, section for section, and weight for weight is considerably stronger than wrought iron.

I am not trying to prove that aluminium is a suitable material for structural purposes, where strength is the main object. It is not, and neither is any other metal, aside from iron and steel. But aluminium does compare well in strength with other metals, and for purposes where lightness combined with moderate strength is desired, not only will it become useful, but it is being largely used today.

It is doubtful if any one has been seriously misled by any confusion between the strength of aluminium and that of aluminium bronze, or if any well-informed person has proposed to displace iron and steel for structural purposes with aluminium.

The most serious objections which Prof. Crocker urges against aluminium are on the score of its chemical properties, and here his information and reasoning are really unique. "Aluminium bronze," he says, "is remarkably free from tarnishing." "Therefore, freedom from oxidation is another property that is wrongly attributed to aluminium itself." It is true, aluminium bronze is the best of the copper alloys for resisting oxidizing influences; but for the vast majority of uses to which metals are put, it cannot compare with pure aluminium in this respect. Aluminium here ranks with silver and next to gold and platinum. The fallacy of Prof. Crocker's reasoning will be apparent to any one who possesses an aluminium opera glass, or who is acquainted with the fact that next to gold aluminium is the metal most preferred by dentists for dental plate, etc., or that for sign painting and decorative purposes aluminium leaf has the preference over silver leaf, because aluminium remains bright and silver blackens.

What are the facts in regard to the corrodibility of aluminium? In the first place, it is not true generally that "it is equally attacked by acid." Of the common reagents, it is dissolved only by hydrochloric acid, and by the alkaline hydrates or caustic alkalies. Sulphuric and nitric acid act upon it with extreme slowness, not dissolving it appreciably after several days' exposure to their action. But for all ordinary uses these facts are no more against aluminium than against gold that it is dissolved by aqua regia or selenic acid. These strong chemical reagents, the acids, and caustic alkalies, are practically unknown outside the laboratory and chemical manufactory. Because of their strong affinities, they cannot exist in our common surroundings of air, water, food, etc.

The action of the weaker, organic acid, saline solutions, etc., upon aluminium is much less than any other metals except the noble metals. Alkaline carbonates do not dissolve aluminium, nor does soap, as Prof. Crocker states. Air, wet or dry, has absolutely no action on aluminium, nor has water. If it is true, as stated by Prof. Crocker, that "subjected to ordinary moist air, aluminium tarnishes and oxidizes rapidly," I am unable to see the pertinence of his further remark that "it is not affected by sulphur or sulphuretted hydrogen, which is a great advantage." For a metal that is oxidized rapidly by moist air, there would be small use in resistance to sulphur or sulphur gases. Prof. Crocker states that "the ease of oxidizing" of aluminium is "about equal to other metals, such as tin, zinc and iron." The absurdity of this statement would be almost evident to one who had even seen an article made of aluminium. Think of iron or tin dental plates, or of zinc leaf or sheet iron used for decorative purposes, as aluminium sheet, foil and leaf are employed. Prof. Crocker constantly asserts that "aluminium really has excellent qualities." I am unable to see what they are on his authority.

One of my associates became interested in aluminium financially largely because of an aluminium field glass which he has possessed for 20 years. He has carried it all over the world. It has been wet with sea water and has been almost constantly exposed to "ordinary moist air" for 20 years, and it has never been cleaned or polished further than wiping it with a handkerchief, and to-day it retains its polish and lustre as perfectly as when new. The fact is, that for resistance to all ordinary corroding and oxidizing influences aluminium stands next to gold and platinum and ranks equal with silver, and the difference between it and the latter metal, aside from difference in color (aluminium being of a bluish tint, which makes silver look yellow by comparison), is just this: For objects that require much handling, aluminium has the disadvantage of losing a portion of its polish, probably from coming in contact with perspiration; but where it is to be exposed to the air of a house or the weather, without much handling, there is no metal which will retain its lustre and polish better. Silver is blackened by exposure to the air, where aluminium is unaffected; while where aluminium is dulled and requires polishing, silver requires the same.

The foreign workers in aluminium seem to have succeeded in giving a more permanent polish and lustre to aluminium under handling than we have in this country; yet, as I judge from some aluminium articles obtained abroad, where polish is unimportant, as for dental plates and culinary utensils, aluminium has no superior short of the noble metals. As regards aluminium cooking utensils, I am not giving this statement off-hand, but from actual experiments extending over more than a year. Cooking utensils of aluminium have been in constant use for the time stated, have been daily subjected to boiling saline solutions, washing with soap, etc., and as a result they are preferred by the users to utensils of any other metal; one reason being that they always are clean and white, while the nickel rivets used for fastening the handles to some of them become perfectly black. In this connection, aluminium cooking utensils will soon be largely placed upon the markets. The same qualities of aluminium are shown by the fact that aluminium vessels have been used for a considerable time for the manufacture of jellies, where freedom from discoloration is important, and besides are now being largely used by one of the large canning concerns in Pittsburgh whose name and products are widely known.

The perfect antiseptic qualities of aluminium should also be noticed, which render it the best metal for culinary uses on this account, and also recommend it for surgical instruments, for which it is largely used at present.

So far as the working qualities of aluminium go, it is well known to be one of the most ductile and malleable of all metals, and therefore is very easily rolled into sheet or drawn into tubes or the very finest wire. Naturally possessing such a high grade of ductility, the metal is of a tough nature, such as would not admit of easy working qualities in the lathe or in the planer; but this toughness or clinging tendency of its fibers can be readily overcome and the metal very easily machined by simply alloying with 3 or 4 per cent. of metallic copper, which shortens the grain, but which does not interfere or change the other qualities or virtues of pure aluminium.

I am glad to see that Prof. Crocker truthfully gives aluminium credit for electrical conductivity, comparing equal weights, twice that of copper. This may be of great importance at no distant day, because, comparing equal weights, aluminium has about 12 times the conductivity of iron, and, while it may not soon compete with copper for insulated wire, it is quite likely to compete with iron for telegraph wire, especially when its perfect durability on exposure to the weather is considered, and as hard-drawn aluminium wire can readily be made having a tensile strength of at least 60,000 lbs. per square inch. There is one of the electrical properties of aluminium of which no mention is made by Prof. Crocker, but which is interesting, although it has not been much investigated nor turned to any practical use. This is its resistance to the destructive effects of the electric spark. Aluminium is superior in this respect to all other metals, and for this reason is employed by Prof. Crookes and others for electrodes in vacuum discharge tubes where electrodes of other metals are quickly torn to pieces. The question suggests itself as to its use for commutators and other electrical purposes, where such a quality is most important.

In the last of his article Prof. Crocker makes the strange statement—a kind of "Irish bull"—that "the purity of aluminium does a great deal toward improving its quality," which indicates possibly that the aluminium upon which his article is founded is not aluminium at all, but that metal plus a considerable amount of iron, silicon, sodium or zinc. His remarks would be very pertinent in regard to such a compound. In this connection, it may be stated that it was never easier to obtain aluminium of the purest quality than at present, since the electrical process has been fully perfected.

The conclusion of Prof. Crocker, and of the editorial founded upon his statements, is that aluminium "is not a promising material for practical use." My belief is just the contrary, and it is founded upon a careful study of the metal and upon the practical tests made of its properties extending over several years, and made with large quantities of metal. There is no more promising material for investigation for practical use; and it has been proved that for a multitude of uses the same results in utility, beauty and durability can be obtained from aluminium at a less cost than from any other metal whatever.

In a paper on aluminium read last winter before the Boston Society of Arts Mr. Alfred E. Hunt, president of the Pittsburgh Reduction Company, in order to give a new turn to a discussion that had fallen into a rut, ventured the statement that aluminium had been overrated, as it has been by some of the unscientific papers. But now every one writing about the metal has taken the cue until aluminium has no good qualities left whatever, but is a weak, easily corrodible metal, like zinc or tin, and really "takes up more space than it is worth," and has falsely appropriated the good qualities of its alloys. Aluminium has been overrated. There has been a kind of "glamour" associated with it, due to two facts; the first being that it is really useful, durable and beautiful, combined with the other fact, which has little to do with its commercial importance, that is, its ores are more abundant than of any other metal and constitute a large portion of the earth's crust.

The world has been centuries in learning to use other metals; in learning to roll, draw, temper and polish them. Aluminium is new, but we are learning how to deal with it; how to secure the qualities of strength, hardness, ductility, lustre, etc., where required, much more rapidly than has occurred in the history of the other metals.

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1600.——Gilbert—Gilberd—(William), of Colchester, physician to Queen Elizabeth of England, justly called by Poggendorff "The Galileo of Magnetism," publishes his great work, "De Magnete Magneticisque Corporibus, et de Magno magnete tellure; Physiologia nova, etc.," wherein the phenomena of electricity are first generalized and classified. Therein he enumerates all the substances which he found susceptible of electrical excitation, and makes first use of the terms electric force, electric emanations and electric attraction.

The first chapter of "De Magnete" treats of magnetism and the second of electricity. The distinction between the two Gilbert establishes as follows: "The difference between magnetic and electric force is, that all magnetic bodies attract by their mutual strength, while in electric bodies the electric attracts only; the body attracted is not changed by its natural force, but is drawn spontaneously by the nature of the material of which it is composed. Bodies are drawn toward electric bodies in a straight line toward the centre of electricity, but the magnet attracts the magnet only at the poles directly, at other points obliquely and transversely, even as they adhere and hang together. Electric motion is the motion of an accumulation of matter; magnetism, of arrangement and order. The globe of the earth is collected and coheres by electricity. The globe of the earth is directed and moves by magnetism, and at the same time it also coheres and is welded together in its inmost parts so that it becomes solid."

The account of Gilbert's experiments appears at chapter II. of the second book, and in the eighth chapter of the fourth book he gives a description of the "composition of the nautical compass, etc."

The second edition of "De Magnete" appeared at Stettin in 1628 "embellished with a curious title page in the form of a monument . . . and a fantastic indication of the earliest European mariner's compass, a floated lodestone, but floating in a bowl on the sea and left behind by the ship sailing away from it!" The volume of "Good Words" for 1879, from which the above is taken, has a *fac-simile* reproduction of the monument at page 383.

The Rev. William Whewell (See A. D. 1835) says, in his "History of the Inductive Sciences" (vol. III., p. 49) that in the "De Magnete," a book of only 240 pages, upon which Dr. Gilbert had been engaged for eighteen years, are contained "all the fundamental facts of the science, so fully examined, indeed, that, even at this day, we have little to add to them."

Regarding this same production, Prof. Robison, of the Edinburgh University, thus expressed himself in the early part of the present century: "It is not saying too much of this work to affirm that it contains almost everything we know of magnetism. His unwearied diligence in searching every writing on the subject and in getting information from navigators, and his incessant occupation in experiments, have left very few facts unknown to him. We meet with many things in the writings of posterior inquirers, some of them of high reputation and of the present day, which are published and received as notable discoveries, but are contained in the rich collection of Doctor Gilbert."

The learned historian, Thomson, in his "History of the

*Continued from THE ELECTRICAL WORLD, May 23, 1891.

Royal Society," London, 1812, thus refers to "De Magnete": "Dr. Gilbert's book on magnetism, published in 1600, is one of the finest examples of inductive philosophy that has ever been presented to the world. It is the more remarkable because it preceded the "Novum Organum" of Bacon, in which the inductive method of philosophizing was first explained." In concluding this portion of our subject we will quote from the testimony of the eminent historian Hallam to the debt which science in general owes to the memory of William Gilbert. "The year 1600 was the first in which England produced a remarkable work in physical science; but this was one sufficient to raise a lasting reputation for its author. Gilbert, a physician, in his Latin treatise on the magnet, not only collected all the knowledge which others had possessed on the subject, but became at once the father of experimental philosophy in this island, and, by a singular felicity and acuteness of genius, the founder of theories which have been revived after a lapse of ages, and are almost universally received into the creed of science. Gilbert was one of the earliest Copernicans, at least as to the rotation of the earth, and with his usual sagacity inferred, before the invention of the telescope, that there are a multitude of fixed s ars beyond the reach of our vision." ("Introduction to the Literature of the Fifteenth, Sixteenth and Seventeenth Centuries.") "*Mahomet's Tombe*, at Mecha, is said strangely to *hang* up, attracted by some invisible *Loadstone*, but the memory of this *Doctor* will never fall to the ground, which his incomparable book 'De Magnete' will *support* to eternity." ("History of the Worthies of England," Thomas Fuller, D. D. London, 1662.)

"Gilbert shall live till loadstones cease to draw
Or British fleets the boundless ocean awe." (Dryden.)

See De Humboldt, "Cosmos," vol. I., p 170; vol II., pp. xx., 725, 726; vol. V., p. 58, for references to and extracts from Dr. Gilbert's work; likewise, Mr. Conrad W. Cooke's article on Gilbert, published by London *Engineering* in December, 1889. See also Whewell, "History of the Inductive Sciences," vol. I., pp. 274, 275, 394. vol. II., pp. 192, 217–220, 224, 225; "Mémoires de Physique," Lausanne, 1754, pp. 123, etc.

A. D. 1609.—Kepler—Keppler—(Johann), who succeeded Tycho Brahe, in 1601, as astronomer to the German Emperor Rudolph II., is the author of a treatise "On the Magnet," which is followed, during 1609, by his greatest work, the "Astronomia Nova."

The last-named contains the extraordinary book "on the motion of Mars," and is said to hold the intermediate place, besides being the connecting link, between the discoveries of Copernicus and those of Newton. Kepler's doctrine, as enunciated by Dr. Whewell ("Physical Astronomy," chap. I.), is that a certain Force or Virtue resides in the sun, by which all bodies within his influence are carried around him. He illustrates ("De Stella Martis," p. 3, c. xxxiv.) the nature of this virtue in various ways, comparing it to Light and to the Magnetic Power, which it resembles in the circumstances of operating at a distance, and also in exercising a feebler influence as the distance becomes greater. . . . In the table of contents of the work on the planet Mars, the purport of the chapter to which allusion has been made is stated as follows: "A physical speculation, in which it is demonstrated that the vehicle of that Virtue which urges the planets, circulates through the spaces of the universe after the manner of a river or whirlpool (*vortex*), moving quicker than the planets." It will doubtless be found, by any one who reads Kepler's phrases concerning the *moving force—the magnetic nature—the immaterial virtue* of the sun, that they convey no distinct conception, except so far as they are interpreted by the expressions just quoted. A vortex of fluid constantly whirling around the sun, kept in this whirling motion by the rotation of the sun himself, and carrying the planets around the sun by its revolution, as a whirlpool carries straws, could be readily understood; and though it appears to have been held by Kepler that this current and vortex was immaterial, he ascribes to it the power of overcoming the inertia of bodies, and of putting them and keeping them in motion, the only material properties with which he had anything to do. Kepler's physical reasonings, therefore, amount, in fact, to the doctrine of vortices around the central bodies and are occasionally so stated by himself; though by asserting these vortices to be "an immaterial species," and by the fickleness and variety of his phraseology on the subject, he leaves his theory in some confusion; a proceeding, indeed, which both his want of sound mechanical conceptions and his busy and inventive fancy might have led us to expect. Nor, we may venture to say, was it easy for any one at Kepler's time to devise a more plausible theory than the theory of vortices might have been made. It was only with the formation and progress of the science of mechanics that this theory became untenable.

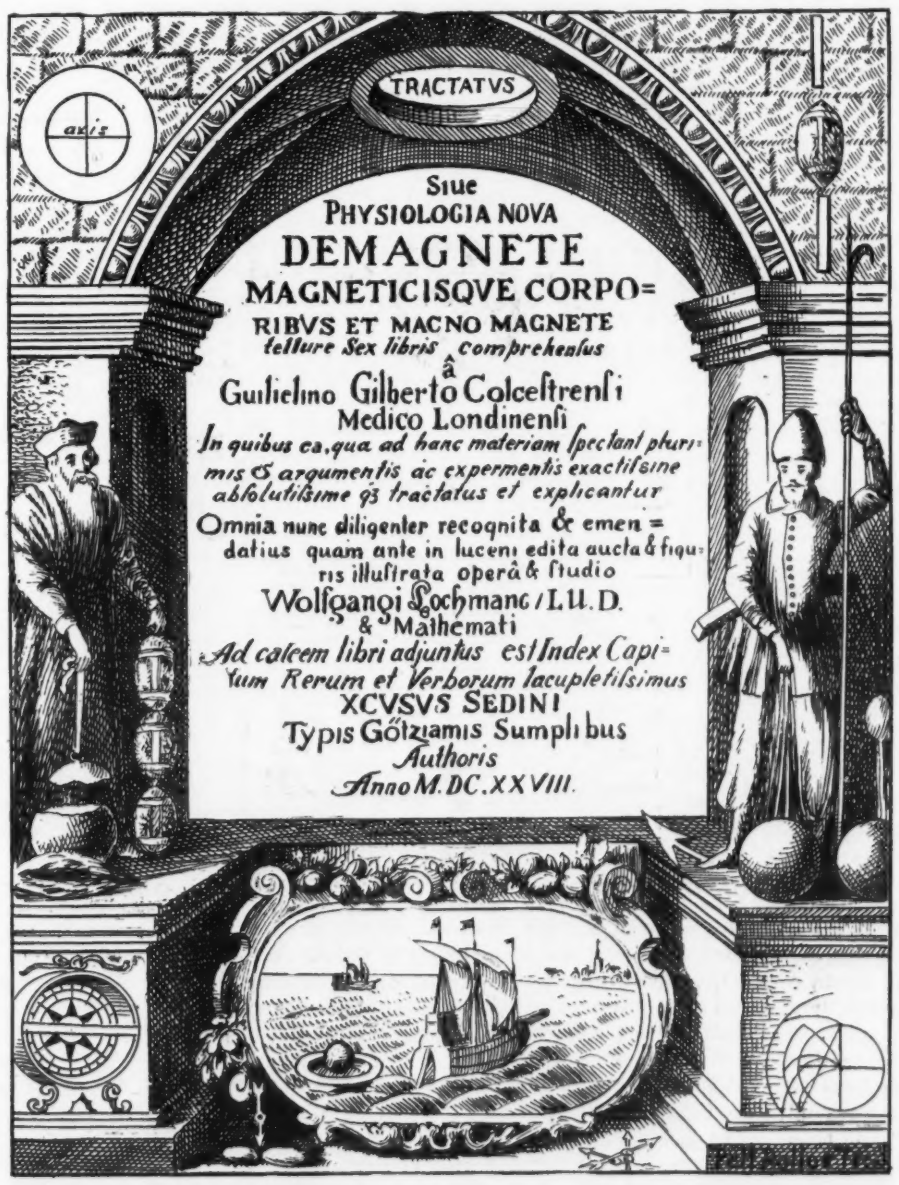
See: "Epistolæ ad J. Keplerum, etc.," published by M. G. Hansch in 1718; Fourth Dissertation of "Encycl. Brit."; Whewell, "History of the Inductive Sciences," 1859, vol. I., pp. 291–311, 320, 386, 387, 415, 462, 532–534; vol. II., pp. 55, 56; also vol. I., pp. 323, 387, 393, 405, 406,

WILLIAM GILBERT.

(From a print in the Park Benjamin collection.)

respecting Galileo's pupil, Giovanni Alfonso Bovelli, and pp. 303, 304, 354, 395, concerning the celebrated young English astronomer Jeremiah Horrox—Horrockes—(1619–1641).

A. D. 1602.—Blundeville (Thomas) publishes at London, "The Theoriques of the Seuen Planets, etc.," which, as the lengthy title goes to show, indicates "the making, description and vse of two ingenious and necessarie instruments for sea men to find out thereby the latitude of any



FAC-SIMILE TITLE PAGE OF GILBERT'S "DE MAGNETE," SECOND EDITION, 1628.

micæ," wherein he describes (lib. II., prol. VI.) a suppositious contrivance of two magnetic needles attached to dials bearing a circle of letters, and which possesses the property of always indicating the same letter, so that when one needle is made to point to any particular letter upon one dial, the other needle, however distant at the time, places itself so as to point to the same letter upon the other dial.

The description is best given in his own words taken from the original Latin (Stradac, "Prol. Acad.," Oxoniæ, 1662, "Magnescur ferrum aut aurum trahat," pp. 326–335).

. . . "If you wish your distant friend, to whom no letter can come, to learn something, take a disc, or dial, and write round the edge of it the letters of the alphabet in the order in which children learn them, and, in the centre, place horizontally a rod, which has touched a magnet, so that it may move and indicate whatever letter you wish. Then, a similar dial being in the possession of your friend, if you desire privately to speak to the friend whom some share of the earth holds far from you, lay your hand on the globe, and turn the movable iron as you see disposed along the margin of all the letters which are required for the words. Hither and thither turn the style and touch the letters, now this end, and now that . . . Wonderful to relate, the far-distant friend sees the voluble iron tremble without the touch of any person, and run now hither, now thither; conscious he bends over it and marks the teaching of the rod. When he sees the rod stand still, he, in his turn, if he thinks there is anything to be answered, in like manner, by touching the various letters, writes it back to his friend." . . .

See *The Student; or Oxford and Cambridge Misc.*, 1750, vol. I., p. 254; Abbé Moigno's "Traité de Tel. Elec." p. 58; Addison (Joseph), *Spectator* for 1711, No. 241; *The Guardian* for 1713, No. 119, and *Nature*, XVI., 268, 269.

A. D. 1620.—Bacon (Sir Francis), by many considered the greatest of English philosophers and philosophical writers, who was knighted in 1603, became Lord Verulam in 1618 and Viscount St. Albans in 1620, produces the masterpiece of his genius, the "Novum Organum," after having twelve times copied and revised it. The last named work, observes Macaulay, "takes in at once all the domains of science—all the past, the present and the future, all the errors of two thousand years, all the encouraging signs of the passing times, all the bright hopes of the coming age." Professor Playfair says of it, that "the power and compass of the mind which could form such a plan before hand, and trace not merely the outline but many of the most minute ramifications of sciences which did not yet exist, must be an object of admiration to all succeeding ages."

Treating of the electric fluid, Bacon has given ("Physiological Remains," London, 1648) a detailed list of attractive and non-attractive bodies and the results of his very extensive experiments and observations in physical science generally, as well as of the investigations contained in Dr. Gilbert's work. To the latter, however, many allusions had already been made in Bacon's "The Advancement of Learning," published during 1605, two years before he was made Solicitor General.

In Section III. of his "Novum Organum," treating of the Doctrine of Instances, he cites:

Instantiæ Citantes, to which may be reduced the "discovery of a moving magnetic fluid, or an action circular and perpendicular to the electrical current, yet connected with it."

Instantiæ Supplementi, such as the magnet which attracts iron through many substances that may be interposed. Perhaps, says he, "some medium may be found to deaden this virtue more than any other medium; such an instance of *substitution* would be in the way of degree, or *approximation*"; that is, it would approach toward destroying the magnetic virtue. Iron possesses, perhaps, this quality in a more marked manner than any other substance.

Instantiæ Radii, leading to the suggestion that there may exist some kind of "magnetic virtue which operates by consent, between the globe of the earth and heavy bodies; or between the globe of the moon and the waters of the sea; or between the starry heavens and the planets, by which they may be drawn to their apogees," or greatest distances from the earth.

Instantiæ Magicæ, such as the loadstone animating a number of needles without loss of its own magnetism.

Motus Magneticus, such as the attraction of the heavenly bodies, from an idea, perhaps, that it might be due to a species of magnetism.

Motus Excitationis, such as the new property which is given to iron by the magnet without any loss of power by the latter.

place upon the sea or land, in the darkest night, that is without the helpe of sunne, moone, or starre; first invented by M. Doctor Gilbert, a most excellent philosopher, and one of the ordinarie physicians to Her Majestie. . . ."

A. D. 1616.—Van Schouten (Cornelius) indicates points lying in the midst of the Pacific and southeast of the Marquesas Islands in which the variation is null. De Humboldt adds ("Cosmos," vol. I., p. 181, and vol. V., p. 58) "even now there lies in this region a singular, closed system of isogonic lines, in which every group of the internal concentric curves indicates a smaller amount of variation."

A. D. 1617.—Strada (Famianus), an Italian author and Jesuit priest, publishes his curious "Prolusiones Acade-

Motus Fugæ, such as "the repulsion of electrified pith balls; also of the similar poles of two magnets. In the latter case, all the force of a strong man has proved insufficient to make the two north poles touch each other."

It was Sir John Herschel who remarked that "previous to the publication of the 'Novum Organum' natural philosophy, in any legitimate and extensive sense of the word, could hardly be said to exist." In the address presented in 1623 by the University of Oxford to Sir Francis Bacon, he is represented "as a mighty Hercules, who had by his own hand greatly advanced those pillars in the learned world which by the rest of the world were supposed immovable."

See account of Lord Bacon's "Novum Organum" in "Library of Useful Knowledge"; "Epitome of Electricity and Galvanism," Phila., 1809, pp. xvi. and 105; and the last edition of Bacon's works, edited by Ellis, Spedding & Heath, 7 vols., 1857, with the Life and Letters by J. Spedding. See also Whewell, "History of the Inductive Sciences," vol. I., pp. 339, 385, 494, 530.

A. D. 1620–1655.——Bergerac (Savinien Cyrano de), a very witty French writer, is the author of a fragment on physics, as well as of a curious philosophical romance, "Histoire comique de l'empire de la lune," a translation from which latter is here given, as in a measure suggesting the phonograph: "On opening the box I found a number of metallic springs and a quantity of machinery resembling the interior of our clocks. It was, in truth, to me a book, indeed a miraculous book, for it had neither leaves nor characters, and to read it one had no need of eyes, the ears alone answering the purpose. It was only necessary to start the little machine, whence would soon come all the distinct and different sounds common to the human voice."

As has been said by one of his biographers, "amid the extravagance of some of his works, Bergerac nevertheless exhibited a pretty good acquaintance with the philosophy of Descartes."

See article "Aeronautics," in the "Ency. Brit.," 1853, vol. II., p. 168.

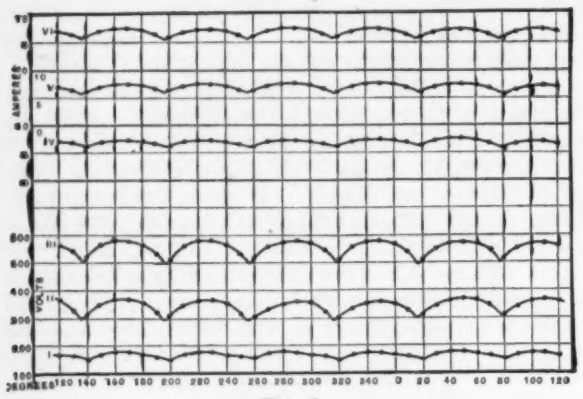


Fig. 3.

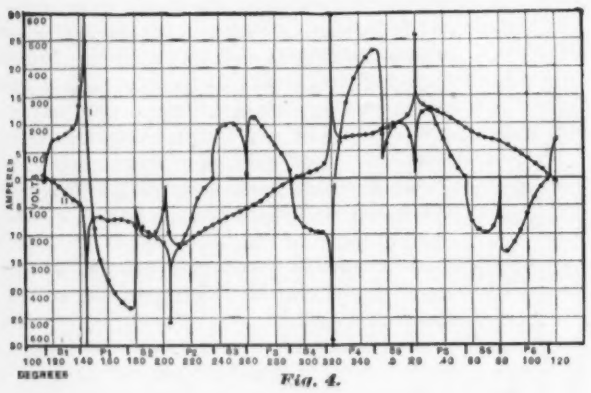


Fig. 4.

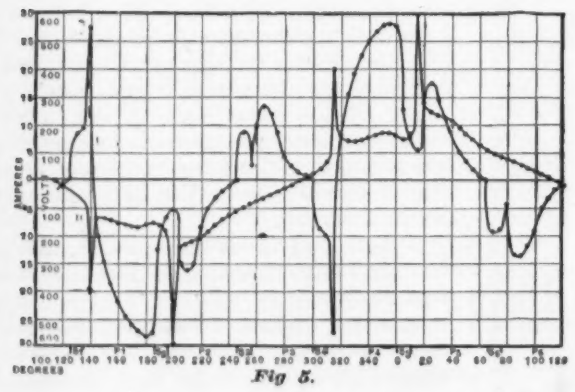


Fig 5.

Frankfort Exhibition.

The Allgemeine Elektricitäts-Gesellschaft and the Maschinenfabrik Oerlikon have now definitely undertaken to contract for transmitting power electrically from Lauffen to Frankfort, and are bound under heavy penalties to finish the work at the latest by Aug. 15. There is, therefore, no longer any doubt but that this important experiment, the successful issue of which will greatly interest the scientific world, will soon be an actual fact.

A Study of an Open Coil Arc Dynamo.*

BY MILTON E. THOMPSON.

Of all the dynamo machines in use at the present day, perhaps the internal action of none is so little understood as that of the arc-lighting machines of the open-coil armature class. Much concerning the regulation and general behavior of these machines seems utterly at variance with what one would naturally expect from a superficial examination of the design and construction, and it was with the idea of throwing some light on this seeming mystery that the investigation to be described was undertaken. In carrying out this work no attempt has been made to determine the efficiency of the dynamo, or to determine an answer to the question—Is the machine well suited for arc lighting? The vast numbers of these dynamos in daily use in all parts of the world is a practical answer which must carry more weight than any which might be suggested by a theoretical study of the machine. The experimental work of this investigation was carried out under the direction of Prof. Nichols in the laboratories of Cornell University, during the past winter, by the writer, with the assistance of Mr. H. J. Hotchkiss and Mr. E. L. Morley, and due credit must be given to these gentlemen for any points of interest which may have been brought out by the investigation.

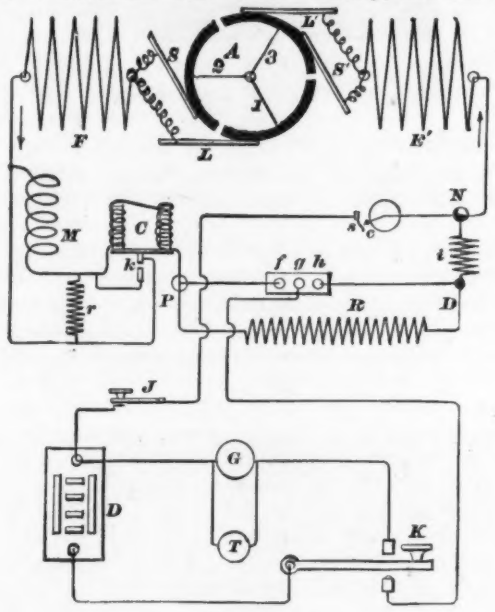


Fig. 1.

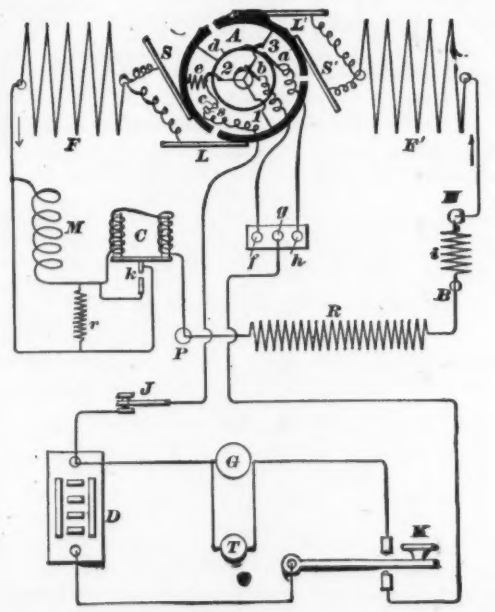


Fig. 2.

The object in view was to determine accurately, by taking instantaneous values throughout the revolution, the character of the external and internal currents and electromotive forces.

The capacity of the dynamo in question was about 10 arc lamps of 1,200 c. p.

In order to carry out this work it was necessary to build a special commutating device of a character somewhat similar to a number of others before used in the Cornell laboratories for taking instantaneous values of current and potential. Prof. Ryan was the first to introduce this method at Cornell, which is a modification of that described by Joubert in 1881,† and the device he used was described at length in a paper read before the Institute‡ on Dec. 17, 1889. The device consisted essentially of a metal tongue mounted upon the shaft of the dynamo and revolving with it, and making contact once each revolution with a small metal spring mounted upon an arm which was so arranged that it could be revolved about an axis coincident with that of the armature of the dynamo and secured in any desired position. By properly adjusting the position of the arm carrying this spring, contact could be made to take place between the spring and the tongue at any desired point of the entire revolution of the armature.

Three sets of curves of exterior current and potential were taken with three different loads upon the machine, and three sets of curves of current and potential through a single coil were taken with the same loads. In order to keep the electromotive force as nearly constant as possible, and prevent variations while a set of observations were being taken, the machine was loaded with a german-silver resistance. The loads consisted of about 20, 50 and 80 ohms, respectively, and were equivalent to about 3, 6 and 10 arc lamps. The current for all loads was supposed to be practically constant, and an ammeter placed in the circuit showed but little variation from the normal current of 6.8 ampères. A condenser and ballistic galvanometer were used for making the measurements, and Fig. 1 shows a diagram of the connection of the dynamo and also of the measuring apparatus. Referring to the diagram, *A* is the armature, *F F* the field coils, *M* the regulator magnet, *C* the controller magnet, and *r* the carbon resistance used to prevent excessive sparking at the contacts *K*; *P* is the positive terminal of the machine and *N* the negative, *R* is the german-silver resistance which constituted the load for the dynamo, and *i* is a resistance of about one ohm placed in the circuit to serve as a basis for the current measurements. *L L* and *S S* are the brushes of the dynamo, which bear against the three segments of the commutator, as shown in the diagram; *D* is a condenser, *K* a discharging key, and *J* a small spring switch; *G* is a ballistic galvanometer, through which the condenser was discharged, and *T* is a shunt box for regulating the throw of the galvanometer and bringing it within proper limits. From the negative terminal of the machine, *N*, runs a wire to the commutating device, *c s*, and from that to the switch, *J*. From the positive terminal, *P*, and the binding post, *B*, run wires to *f* and *g* of the switch, *f g h*, as shown. From *g* of this switch runs a wire to the discharging key, *K*.

Before describing the methods of taking the measurements, it may be well to review briefly the operation of the dynamo and its regulation so far as is apparent from an outside view. The current, leaving the armature through the brushes, *L* and *S*, passes through the left field coil and thence through the regulator magnet and controller magnets to the positive terminal, *P*, of the machine. Passing around through the external circuit, in this case the resistance, *R*, the current returns to the machine by the negative terminal, *N*, passes through the right field coil, *F*, and through the brushes, *L* and *S*, to the armature, thus completing the circuit. The regulation of the machine is effected as follows: The controller magnet, *C*, is so adjusted, by means of a spring, that a current of 6.8 ampères will just raise the cords of the magnets and separate the contacts, *k*. This permits the current to flow through the regulator magnet, *M*, and raises the regulator arm, thereby

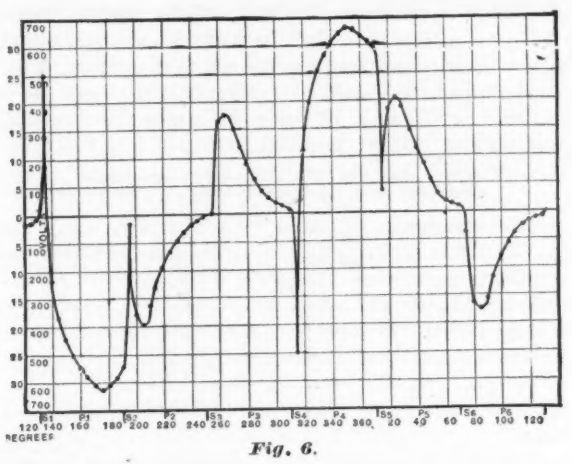


Fig. 6.

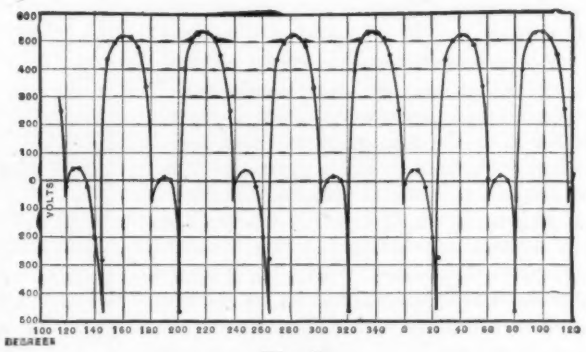


Fig. 7.

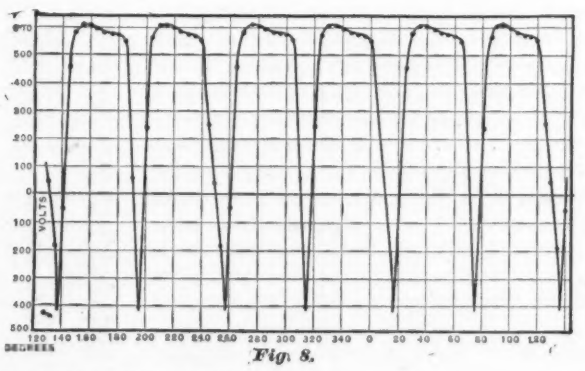


Fig. 8.

*A paper read before the American Institute of Electrical Engineers, May 21, 1891.

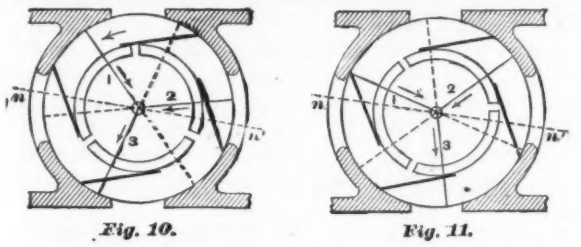
† Joubert; Etudes sur les Machines Magneto-Electriques; *Annales de l'Ecole Normale-Superieur*, 10, 46 pp., 1881.

‡ *Transactions*, vol. VII., p. 3.

A STUDY OF THE FLUCTUATIONS OF ELECTROMOTIVE FORCE IN AN OPEN COIL ARC DYNAMO.

shifting the leading brushes, L and L', forward, and the following brushes, S and S', backward, and thus reducing the potential furnished by the machine. The current is, of course, thereby diminished, and the cores of the controller magnet drop, closing the contacts, k, and thus short-circuiting and cutting out the regulator magnet. The regulator arm then falls, under the action of gravity, and the leading brushes being moved backward and the following brushes forward, the potential is raised until the current increases sufficiently to once more open the contacts, k, and again cut in the magnet of the regulator. The controller magnet acts simply as a relay, and is continually cutting the regulator in and out of the circuit, and in this way the current is maintained constant, regardless of the varying conditions of the external circuit.

During these experiments the regulator was allowed to act just as in ordinary practice, but each load was constant and practically non-inductive. Three sets of curves of external current and potential were taken and the measurements were made in the following manner: The commutating device, $c\ s$, being secured in a fixed position, f and g were connected. The discharging key, K, being then depressed, switch J was then closed, and in a few seconds the condenser became charged with the difference of potential existing between the terminals of the dynamo at the particular point of the revolution of the armature represented by the position of the commutating device. Switch J being then opened, the discharging key, K, was allowed to rise, and the condenser was thus discharged through the galvanometer, G, causing a deflection which was duly noted. The connections of the switch, $f\ g\ h$, were then changed so that g and h were joined, and in this way the condenser was charged with the difference of potential existing between the points B and N of the external circuit at the same point of the revolution as the first reading. The



FIGS. 10 TO 13.—STUDY OF AN OPEN COIL ARC DYNAMO.

condenser was then discharged through the galvanometer and the deflection noted as before.

After moving the contact spring, s, forward 10 degrees, the measurements just described were repeated, and so on until the contact had been moved entirely around the circle.

The condenser and galvanometer being properly calibrated, it was an easy matter to calculate from the data obtained as above the difference of potential between the terminals, P and N, and between B and N, at 36 points of the revolution of the armature. The resistance between B and N being known, the current was readily determined from the fall of potential. The results of these measurements are given in Table I. and are shown graphically in Fig. 3, and will be referred to later.

After taking curves of the exterior potential and current, the apparatus was arranged for measuring the potential and current in a single coil of the armature. Coil No. 2 was selected as likely to present results nearest the average of all three of the coils, and the apparatus was arranged as shown in Fig. 2. The circuit of the dynamo and its loads were exactly as for the first measurements, and the connections of the measuring instruments were as shown in the diagram. Referring to Fig. 2, a is a small brush which bears against a ring d secured to the commutator but carefully insulated from it. This ring is connected to the commutator bar of coil No. 2, and thus gives metallic connection with this bar at all points of the revolution. A small brush, b, bears against a similar ring wound round the armature shaft but insulated from it. This last ring is connected to the three inner ends of the three coils, and thus a continuous contact is made with these ends. The outer end of coil No. 2 was disconnected from the commutator bar, and a small non-inductive resistance, e, was inserted between the end of the coil and the bar. The junction of the coil and the resistance, e, was connected to the tongue, c, which revolved with the armature shaft. Once during each revolution the tongue, c, made contact with the small spring, s, from which a wire ran to the switch, J, and thence to one terminal of the condenser, D. Wires ran from brushes, a and b, to the switch, $f\ g\ h$, and from this switch a wire ran to the discharging key, K, as shown on the diagram. When g and h were connected and keys J and K depressed, the condenser was charged with the difference of potential existing between the ends of coil 2 as the particular point of the revolution represented by the position of the contact spring, s. The condenser being then discharged through the galvanometer, a measure of this difference of potential was thus obtained. Switch $f\ g\ h$ was then changed so that g and h were connected, and measurements then taken with the condenser and galvanometer gave the difference of potential between the ends of the non-inductive resistance, e, and from this the current in coil 2 was calculated. Readings were taken in this way at distances of five degrees apart all around the revolution, and the results are given in Table II., and are shown plotted out in Figs. 4, 5 and 6, three curves at three different loads being taken, as before. It is not the purpose of the writer to go into the theories of cause and effect as exemplified in these curves, but to simply present them, calling attention briefly

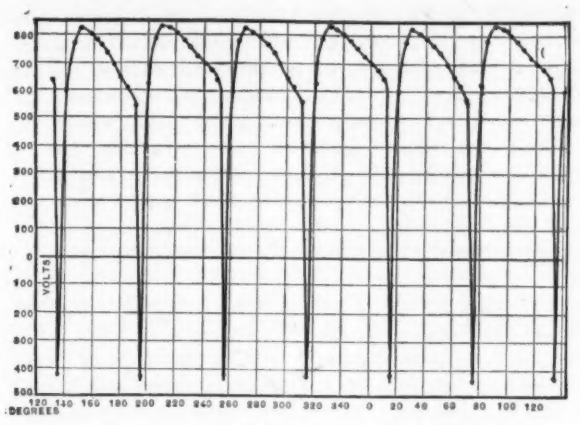


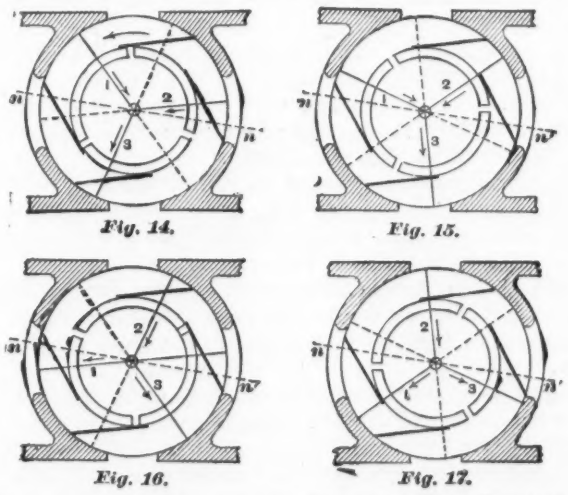
FIG. 9.—CURVE OF POTENTIAL AT THE BRUSHES.

to some few of the more noticeable and interesting features connected with them.

Turning now to the results obtained, in Fig. 3, curve I represents the difference of potential at the terminals of the dynamo throughout the revolution under a light load, and curve IV is the corresponding current. Curve II is the potential for medium load, and curve V the corresponding current, while curves III and VI represent the potential and current at full load. It will be noticed that the curves for medium and full loads are practically alike, while the curve for light load differs slightly in its character and is less symmetrical, and its minimum points occur slightly later than in the other curves. The curves of current and potential are practically alike, as might be expected since the self-induction of the external circuit was little or nothing. The curves are all of them about such as would result from a closed coil armature with a six part commutator. It may be well to remark that in taking the observations for these curves closer readings than are shown were taken near the minimum points, so as to be sure these points were correctly placed.

These curves show that the external current is continuous and much steadier and more uniform than is usually supposed.

Referring to Fig. 4, we find that the state of affairs in a single coil is quite different from that at the terminals of the dynamo. Curve I represents the difference of potential at the ends of the coil throughout the revolution, and curve II is the current in the same coil during the revolution. The curves shown in Fig. 4 were taken with a light load. Figs. 5 and 6 show curves taken with medium and with full loads. For some unknown reason it was found impossible to get accurate readings for the current at full



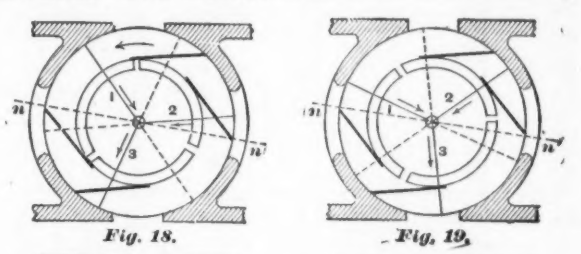
FIGS. 14 TO 17.—STUDY OF AN OPEN COIL ARC DYNAMO.

load, and so no current curve is given in Fig. 6. It is probable, though, from the similarity of the current curves at light load and at medium load, that the current for full load differed very much from the other two.

It will be noticed that at all loads the potential changes sign no less than six times during the revolution and falls to zero, or almost to it, as often as 12 times, while the current reverses but twice during the revolution and for the most part goes through very gradual changes. At the bottoms of the figures are lines of spaces showing the positions of the armature during the part of the revolution represented by the curves above them. s_1, s_2, s_3 are the periods of short circuit, and p_1, p_2, p_3, etc., are the periods during which two coils are usually supposed to be in parallel with each other and in series with the third coil. There are six periods of each kind in the course of each revolution. Figs. 10, 14 and 18 represent the relative positions of commutator and brushes at the three different loads during the parts of revolution shown at s_1. For the light load this period is about 25 degrees, for the medium load about 10 degrees, and for full load not more than one degree. The periods shown are not the *actual*, but the *apparent* periods of short circuit, as it would seem to be from the positions of the commutator and brushes. The *actual* periods of short circuit are somewhat longer, owing to the conductivity of the spark, and last until the spark is blown out. The exact point of the revolution represented by Figs. 10, 14 and 18 is the point 130 degrees, as marked below the curves. Figs. 11, 15 and 19 represent the positions of the brushes and commutator for the parallel periods p_1, or, to give the exact position shown, 160 degrees. Figs. 12, 16 and 20 represent the second short circuit, s_2, and Figs. 13, 17 and 21 show the second periods of parallelism, p_2, or 220 degrees In all of these figures the relative positions of the coils and poles of the dynamo are also shown, the coils being numbered 1, 2, 3, just as they are on the dynamo. During the entire period represented by each four figures as above, the armature has turned through 120 degrees, or one-third of the revolution; and if we now consider the position of coil 2 changed to that of coil 1 in each figure, our figures will then represent the next third of the revolution. If coil 3 is supposed to occupy the position of coil 1, we shall then have the remaining third of the revolution.

It will be noticed that the more sudden and violent changes of potential occur just as the spark is forming and being broken at the front end of the commutator bar.

In examining these curves of potential it should be remembered that they represent the *difference* of *potential* at the ends of the coil and *not* the E. M. F. developed in the coil during the revolution. The sudden and marked changes in current which are shown at certain points of the current curves are selected from a number of readings



FIGS. 18 TO 21.—STUDY OF AN OPEN COIL ARC DYNAMO.

which showed great variation. In some cases the reading had an opposite value from that shown in the curve, and it seems probable that, all things considered, the average value of these points should be very little, if any, different from the others, and the whole should form a smooth curve without any very sudden changes. In Figs. 10 to 21 the arrow shows the direction of the current in each coil during that particular part of the revolution represented by the figure. In each of these figures a neutral line $n\ n'$ is shown, in passing which the current in each coil becomes zero and reverses. It will be noticed that the direction of the currents in the various coils for the so-called periods of parallelism and short circuit is quite different from what would be naturally expected and from what has been supposed to be the case in most of the descriptions of the action of this machine. For instance, in Fig. 11 we have the current in coil 1 flowing *toward* the junction of the three wires, showing that a current is flowing from the junction through coil 3 to the left pair of brushes and back through coil 1 to the junction again, or, in other words, that coils 1 and 3 are short circuited upon each other. This state of affairs continues, with the light load, until commutator bar 3 touches the right following brush and short circuit period s_2 commences. Thus it will be seen that there is no instant during the so-called parallel period when coils 1 and 3 are in parallel and that the *actual* parallelism does not occur until after the beginning of the period of short circuit. In the case of medium and full loads, however, it occurs at from 10 to 20 degrees before the period of short circuit. Another point worthy of notice is, that at the first instant of short circuit, when the commutator bar just touches the following brush, there is no sudden increase of current, as would be naturally expected, but the current in the short circuited coils slowly and gradually increases until the short circuit is broken by the blowing out of the spark, at which instant the current is a maximum in the coil whose commutator bar is opposite the sparking point, and in the other two coils it is about the same as the normal external current.

In Figs. 7, 8 and 9 are shown curves of potential at the brushes, at the three different loads. These curves were obtained from the potential curves of Figs. 4, 5 and 6, by adding together the potentials of the three coils according to their relative positions, and thus obtaining the potential at the brushes. It will be noticed that at all loads the curves fall below zero six times during each revolution,

and that the difference in area and consequent effective E. M. F. is obtained more by the widening out of the curves than by increase in height. This is what we ought to expect from the change in duration of the short circuit periods. A comparison of these three curves of potential at the brushes with the three curves of potential at the terminals of the dynamo will give one a good idea of the remarkable steadying power which magnets such as the fields of this dynamo exert upon an intermittent current. No further explanation is needed of the fact that this dynamo will not work as a separately excited machine. The whole set of curves will serve to illustrate some of the very remarkable effects of armature and field reactions, and any one sufficiently interested to make a detailed study of them might possibly succeed in bringing out a number of curious and interesting, if not useful, results.

It is to be regretted that time did not permit the measurement of the exact electromotive force developed in a separate coil of the armature, as distinct from the difference of potential at the ends of the coil, and also the measurement of the changes of magnetism occurring in the fields of the dynamo. With the help of this additional data a very complete study of the internal actions of the machine might have been made, and possibly results might have been obtained which would throw useful light upon the interesting subject of armature reactions. The writer hopes at some time in the near future to make a further study of the machine in this respect and to present any further data obtained in this way as a supplement to this paper.

TABLE I.

EXTERNAL CURVES.

	Light load.		Medium load.		Full load.	
Degrees.	Volts.	Ampères.	Volts.	Ampères.	Volts.	Ampères.
120	166	6.8	362	6 8	561	6.8
130	162	7.0	328	6.5	546	6.3
140	150	6.2	308	5.9	516	5.9
150	165	6.9	337	6.7	561	6.6
160	172	7.0	362	7.0	573	7.2
170	176	7.4	360	7.4	570	7.4
180	168	6.8	352	7.0	563	6.8
190	158	6.6	316	6 4	526	6.3
200	146	6.1	294	6.0	509	5.9
210	168	6.9	336	6.9	561	6 8
220	178	7.4	352	7.0	571	7.4
230	176	7.2	360	7.1	566	7.0
240	162	6.6	350	7.0	553	6.6
250	160	6.3	308	6.3	524	6.1
260	150	6.1	305	6.2	516	5.9
270	168	6.8	336	6.7	558	6.8
280	178	7.2	350	7.0	568	7.2
290	170	7.0	354	7.1	566	7.0
300	162	6.8	352	7.0	561	6.8
310	160	6.5	313	6.4	540	6.3
320	148	6.2	308	5.8	505	5.9
330	168	6.9	334	6.5	554	6.6
340	176	7.4	347	7.0	571	7.4
350	174	7.4	352	7.2	568	7.2
0	166	6.8	352	7.1	565	6.8
10	162	6.7	326	6.4	536	6 6
20	148	6.1	308	6.0	495	5.7
30	168	6.8	342	6.8	546	6.6
40	176	7.2	360	7.2	563	7.0
50	178	7.4	365	7.3	568	7.2
60	168	6.9	362	7.1	561	6.8
70	160	6.6	345	6.7	546	6.3
80	152	6.3	305	5.9	514	5.9
90	162	6.6	336	6.3	546	6.8
100	176	7.3	360	7.0	568	7.2
110	174	7.2	365	7.2	568	7.2

TABLE II.

INTERNAL CURVES.

	Light load.		Medium load.		Full load.	
Degrees.	Volts.	Ampères.	Volts.	Ampères.	Volts.	Ampères.
120	140+	.28—	13—	1.31	33—	
125	149	1.43	0	2.2	24	
130	160	2.56	170+	3.0	15	
135	173	3.71	190	3.25	500+	
140	268	4.28	549	15 0	232—	
145	500	30.0	107—	6.5	368	
150	180—	7.4	292	7.0	445	
155	290	7.0	374	7 2	503	
160	368	7.5	445	7.6	543	
165	409	7.5	490	7.85	580	
170	441	7.6	520	8.15	613	
175	464	7.7	549	8.5	627	
180	173	7.75	560	7.7	607	
185	190	9.2	555	7.3	582	
190	202	9.75	255	8.0	545	
195	190	10.5	130	9.3	37	
200	110	11.1	107	30.0	362	
205	190	26.0	296	12.1	395	
210	235	12.7	320	11.3	325	
215	202	12.0	295	11.1	263	
220	145	10.6	170	10.3	196	
225	65	10.0	105	9.22	137	
230	35	9.3	51	8.1	95	
235	3	8.5	24	7.1	70	
240	175+	7.75	9	6.3	40	
245	192	7.0	0	5.6	27	
250	198	6.5	181+	4.96	18	
255	178	6.0	50	4.25	0	
260	233	5.5	199	3 68	333+	
265	221	4.7	269	3.12	350	
270	195	4.0	237	2.7	303	
275	155	3.0	178	2.2	232	
280	120	2.3	80	1.5	170	
285	90	1.3	55	1.0	119	
290	35	.5	35	.2	76	
295	140—	.28	20	.5+	51	
300	175—	.75+	6+	1.31+	33+	
305	184	1.25	174—	2.18	30	
310	190	1.75	195	3.06	15	
315	193	2.6	549	20.0	500—	
320	580	30.	150+	7.6	220+	
325	149+	7.2	304	7.0	390	
330	276	7.7	380	7.0	505	
335	362	7.6	450	7.3	555	
340	408	7.64	502	7.6	606	
345	437	7.78	535	7.85	641	
350	462	8.0	558	8.5	656	
355	173	8.6	506	8.6	652	
0	122	9.2	555	7.7	631	
5	199	9.9	256	7.3	610	
10	199	10.5	155	8.3	579	
15	149	11.4	107	30.0	74	
20	60	0	275	13.5	368	
25	241	13	347	12 2	407	
30	247	12.7	288	11.6	380	
35	199	12.3	224	11.2	285	
40	140	11.7	161	10.6	235	
45	83	10.8	107	9.22	167	
50	36	9.96	60	8.22	113	
55	9	8.94	35	7.1	59	
60	158—	8.25	14	6.3	39	
65	180	7.76	4	5.6	27	
70	197	7.41	187—	4.96	21	
75	174	7.03	180	4.25	77—	
80	142	6.45	83	3.68	331	
85	283	5.75	270	3.12	349	
90	230	5.0	274	2.7	316	
95	191	4.4	240	2.2	245	
100	127	3.22	186	1.5	165	
105	64	2.2	107	1.0	113	
110	23	1.61	61	.44	76	
115	9	.29	29	.5—	43	

An Alternate Current Potentiometer.*

BY GEORGE S. MOLER.

This device is designed for the purpose of determining what values of the potentials of alternating currents will produce given effects, and is intended to be used mainly in calibrating alternating current voltmeters. It may also be used as a voltmeter, applying it directly to the alternate current to be measured. By means of this apparatus we may determine whether the instrument which is being calibrated changes its reading for other rates of alternations. This is shown by comparing the calibration curves obtained by using widely different rates of alternations.

The instrument, briefly described, is as follows: An incandescent lamp is so arranged and connected that it can be switched back and forth from the terminals of an alternating current line to those of a direct current line, which can be altered in voltage till the lamp glows with the same intensity when fed by either line. Then, while switched into the direct current line, the voltage of that line is measured by a direct current standard voltmeter or potential instrument, and the voltage so read is equivalent to that of the alternating current, which produces the same effect in the lamp. The switch is so constructed that it snaps back and forth, making the change of connection so quickly that the slightest change of intensity of the light can be easily detected. The lamp has a blackened hood with an opening in one side through which it is viewed while the sliding resistance is being adjusted. This enables the observer to make a much closer setting than otherwise. A very close setting may also be made by observing the slight reflection of the light from the blackened surface of the hood.

The lamp and switch are arranged and connected in the following manner: Referring to the diagram, *A* is the alternate current dynamo, or line, of which we wish to determine the effective difference of potential in volts between its two terminals, *B* and *C*; *D* is a storage battery or direct current dynamo of higher voltage than the alternate current to be measured. A switch *E*, made to snap back and forth by means of a stiff spring, changes the incandescent lamp *F* from the alternating current to the direct current and vice versa. By connecting the two extremities of a resistance *H* to the battery *D*, and sliding the contact point *I*, such a place can be found that the intensity of illumination will be the same for both currents.

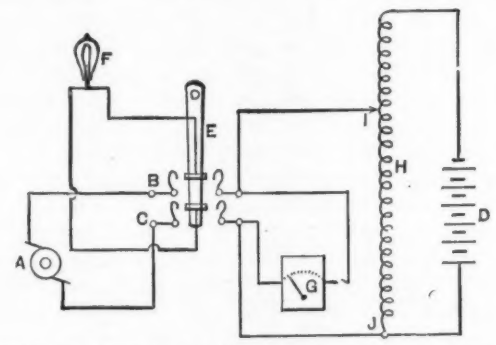


Diagram of Method of Measuring Alternating Current Potential.

After the contact *I* is adjusted, the standard voltmeter *G* is read while the direct current is flowing through the lamp, and this voltage is taken as the equivalent voltage of the alternate current.

A series of lamps of different voltages affords a greater range to the instrument than could be obtained with one lamp only. These may all be connected to the switch, and, beginning at the one of highest voltage, one after another may be tried till the best one is found.

For higher voltages than the highest voltage lamp will stand, a number of lamps may be used in series, and the fall of potential for all, or for each individual lamp, can be measured by means of its voltmeter.

The resistance *H* must necessarily be great enough in amount so that only a small current will be allowed to flow through it, so that the consumption of energy will be small.

Instead of having the switch and lamp connected in a shunt line to the resistance *H*, it may be connected in series with *H*, which must then be arranged so that it can be varied in amount. If a source of constant potential large enough in amount is available, the apparatus may be used for a voltmeter for direct or alternating currents. To use it in this manner, we calibrate the apparatus to find the potentials at the terminals of the lamp for different positions of the contact points *I* and *J*, and construct a curve, using the positions of *I* and *J* as abscissæ and the differences of potential of those points as ordinates. Then, when using the apparatus as a voltmeter, we read the values from this curve instead of from a voltmeter connected to the switch.

The apparatus was tested in the following manner to determine its sensitiveness, and to what extent its indications can be relied upon: The terminals *B* and *C* were connected to the same resistance *H* by two other contact points, and these connections were changed several times to include different amounts of that resistance. Each time this was done the contact point *I* was moved along till the lamp seemed to indicate the same candle power for both positions of the switch. The readings of potential for both positions were then made upon a standard potential galvanometer which has a scale graduated to millimetres, and upon which a double deflection of one centimetre means one volt. Upon this instrument readings could be estimated to one-tenth of a millimetre, giving volts to the second decimal place. The accompanying results were the first part of the first set taken in this manner and were consecutive. They were taken without any preliminary practice. From this it will be evident that the adjustment of the light can be made to within one-tenth of a volt.

Left contact. Volts.	Right contact. Volts.	Diff.
29 95	29.85	+ .1
29.62	29.60	+ .02
33.07	33.11	— .04
37.56	37.55	+ .01
42.52	42 60	— .08
60.95	60.90	+ .05
74.68	74.72	— .04

* A paper read before the American Institute of Electrical Engineers, New York, May 21, 1891.

A New Graphical Method of Calculating Leads for Wiring.*

BY CARL HERING.

The subject of the calculation of leads for wiring has been written about in periodicals and books so often that it may almost be necessary to preface this paper with an excuse for again bringing up at this meeting such a simple and threadbare subject. The calculation of a single pair of leads is such a simple matter that very little need or can be said about it; the formula, if not at hand, can be deduced about as quickly as it can be looked up. But simple as this calculation is, if it has to be made not only tens, but hundreds of times, a method which shortens this work may perhaps be of interest to those whose misfortune it is to have much of this uninteresting work to do. The following suggestions of a graphical method is an attempt to reduce this work to what might be called "machine methods," by substituting for the usual figuring a simple graphical device which requires no figuring at all, and which is at the same time universal in its application, as it is adapted equally well for any of the many different lamps in the market to-day.

Makers and users of one particular lamp can readily calculate a wiring table for that lamp, for each of a few of the usual losses in the leads, and such tables are often quite convenient for those particular conditions; but it is evident that they are limited to those fixed conditions. Their scope can be increased by making simple reductions, but they may then become dangerous tools in the hands of many mechanics who may readily fall into such errors as multiplying instead of dividing by two. Furthermore, such tables are not generally applicable to branched leads, which are so common in wiring, and mechanics (they cannot be called electricians) have frequently made the error of determining from the tables each successive section of a branched wire for the total loss. It is no wonder, then, that they can underbid their competitors. To make a set of tables large enough to cover such fractional losses means to multiply their number considerably. If, in addition to this, such a set of tables is to include all the many different lamps of different makes and candle powers, it is readily seen that the number of tables which become necessary would be greatly burdened by the searches for the special table required for each calculation. As long as there are lamps of such different ampèrage and voltage it would hardly be practicable to make a universal set of tables, especially when the currents which the lamps take are greater than what is claimed for them.

Graphical methods, therefore, suggest themselves, for in these the size of the diagrams does not increase nearly as rapidly for an increased scope as the number of tables would. Graphical methods have been devised to replace the tables, but they have not been satisfactory for various reasons. As early as 1884 a diagram was devised by Emil Waldstrom, which was universal in its scope and exceedingly ingenious. It was based on logarithmic functions, and gave not only the cross-section, but also the diameter of the wire, for any lamps, distances or losses. But the dense network of lines, and the method of using it, were so complicated that only technically trained engineers would be likely to apply it in practice. In the same year the writer devised and used a diagram totally different in principle, which had the advantage over the other in being so simple that it could readily be understood; in fact, it could not be misunderstood, as there was only one set of diagonal lines. It consisted merely of a right angle and a series of diagonal lines drawn through the centre, the background being cross-hatched. It was not universal, however, as it had to be made for each special lamp; but it had the redeeming feature that any one could readily make such a diagram on cross-section paper for any particular lamp and scope. This diagram was described by the writer in the *Electrical Engineer* of January, 1887, and is doubtless known to many, as it has since been copied and published by some one else in a well-known book on wiring, though without any acknowledgment of the true authorship. This diagram, however, is only a partial solution of the problem, as it performs only two of the three multiplications and divisions required

* A paper read before the American Institute of Electrical Engineers, May 20, 1891.

by the formula; it is necessary first to multiply arithmetically the number of lamps by the distance in feet, the diagram will then perform the remaining multiplication and division, both in one operation, giving as the result the size of the wire or the gauge number. To attempt to give on a regular scale the diameter of the wire as distinguished from the cross section, would require a series of parabolas to be drawn; this would render it practically out of the question for any one to make the diagram himself. The simple device was therefore resorted to, to use a regular arithmetic scale of cross sections, instead of diameters or gauge numbers. All the lines then become straight diagonals and are therefore very easily drawn. Furthermore, the different factors which enter into the calculations were so placed on the diagram that the series of hyperbolas called for by the formula resolved themselves all into straight lines.

The objections to this method were that it required a different diagram for each different lamp, and that it did not multiply the number of lamps by the distance in feet. For this reason alone the graphical calculations are that much simpler.

Now, the general formula for wiring is as follows:

$$\text{Cross-section} = \frac{\text{current for one lamp} \times \text{number of lamps} \times \text{distance} \times \text{constant}}{\text{loss in volts}}$$

containing six quantities only, one of which is always constant, being equal to twice the mil foot resistance of copper, if the cross section is in circular mils. As we have just seen, calculations involving three of these five quantities may readily be made graphically by means of a single set of diagonal lines. For instance, for any one make of lamp the current per lamp is a constant, and may therefore be combined with the other constant as one; if, futhermore, the number of lamps and distance be multiplied together mentally and then used as one quantity, lamp feet, there are then only three variable quantities to the formula, and calculations can then be made by one set of diagonals. This will give the diagram mentioned in the early part of this paper. But a universal diagram must be equally well applicable to any lamp; and as graphical calculations are so much simpler, more rapid, and less liable to errors than arithmetical ones, it is preferable to multiply the lamps by the feet graphically also. Both of these may be accomplished by splitting up this formula into smaller ones, each of which contains no more than three variable quantities. Each formula can then be calculated separately by a simple diagram, as described, thus permitting the whole formula to be calculated graphically.

To do this, let the first diagram perform the calculation,

$$x = \frac{\text{current for one lamp}}{\text{loss in volts.}}$$

In which x is a mere auxiliary quantity. Let a second similar diagram perform the next calculation

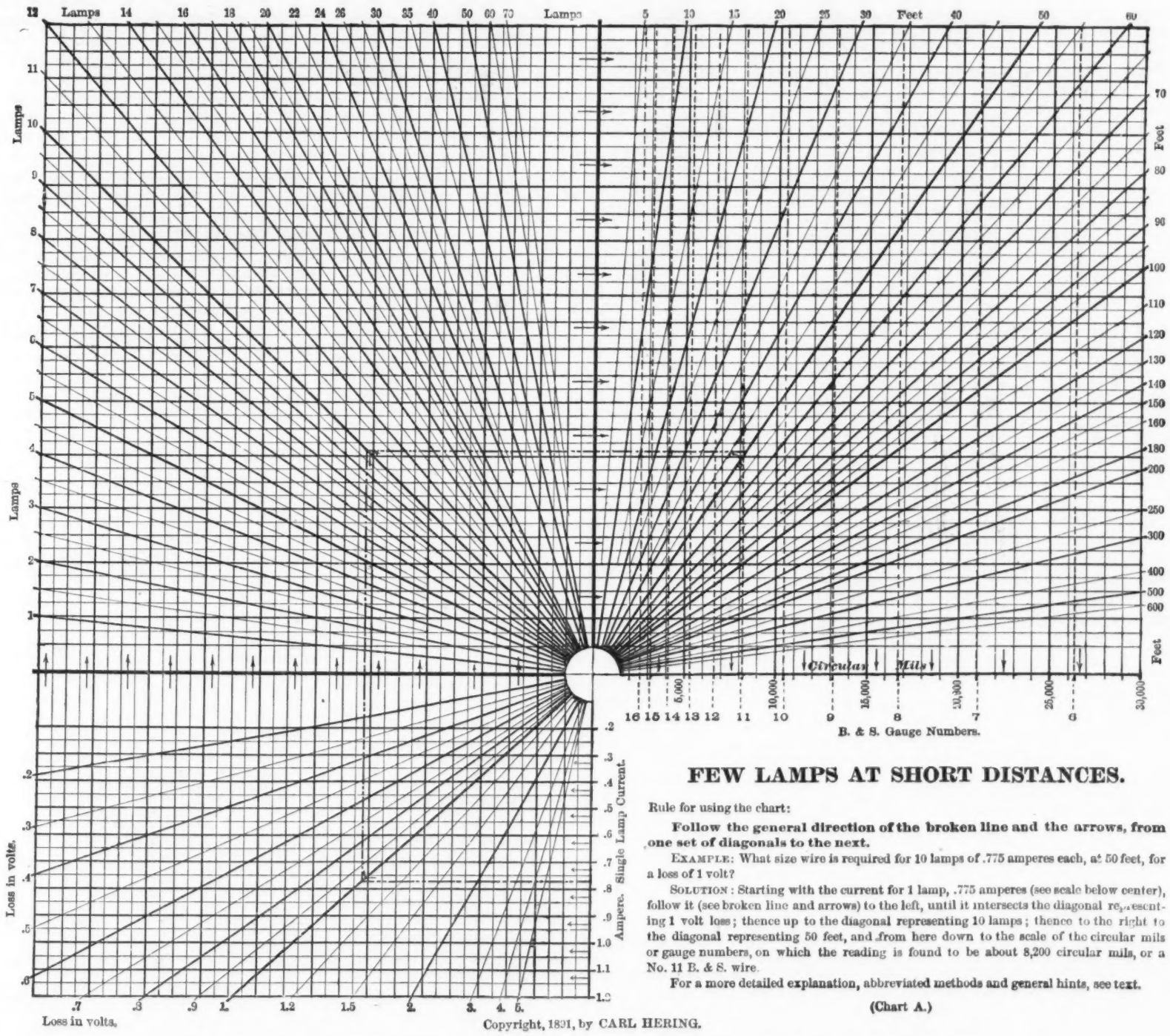
$$y = x \times \text{number of lamps;}$$

and a third diagram the final calculation:

$$\text{Cross-section} = y \times \text{distance.}$$

The constant may be combined with any one of these, it is immaterial which one. This triple calculation may at first seem to complicate matters on account of the new quantities, x and y. These, however, are easily eliminated by the simple device of placing the three diagrams together, side by side, in such a position that the two x scales coincide, and similarly the two y scales. By doing this one has merely to pass directly from one set of diagonals to the next to perform the successive steps of the calculation, without being concerned about the intermediate auxiliary quantities. These intermediate quantities correspond, and are equal to the successive products or quotients which are obtained in the successive arithmetical multiplications and divisions of these five quantities in the formula, which cannot, of course, be eliminated in making the calculations arithmetically, showing another great advantage of the graphical method. This particular method of performing the successive calculations is, of course, not limited to this formula, which is used here merely as an illustration. Any other formula which may be split up into smaller ones, each involving one multiplication or division, can be calculated graphically by the same method.

In the accompanying diagram the formula just given is represented graphically as described. It will be seen to consist of three right angles each with its set of diagonals and a common centre. Each two right angles have one side in common which represents the quantities x and y, and which thereby drop out of consideration. The lower left-hand diagonals represent *loss in volts;* the upper left hand, *number of lamps*, and the upper right hand, *distances.* The remaining two of the five variables are represented by the starting scale vertically below the centre, which represents the *ampèrage of a single lamp*, and the last scale, to the right of the centre, which represents the final result,



FEW LAMPS AT SHORT DISTANCES.

Rule for using the chart:

Follow the general direction of the broken line and the arrows, from one set of diagonals to the next.

EXAMPLE: What size wire is required for 10 lamps of .775 amperes each, at 50 feet, for a loss of 1 volt?

SOLUTION: Starting with the current for 1 lamp, .775 amperes (see scale below center), follow it (see broken line and arrows) to the left, until it intersects the diagonal representing 1 volt loss; thence up to the diagonal representing 10 lamps; thence to the right to the diagonal representing 50 feet, and from here down to the scale of the circular mils or gauge numbers, on which the reading is found to be about 8,200 circular mils, or a No. 11 B. & S. wire.

For a more detailed explanation, abbreviated methods and general hints, see text.

(Chart A.)

CARL HERING'S METHOD OF GRAPHICAL CALCULATION OF LEADS FOR WIRING.

The object of the present diagram is to overcome these two objections. This was accomplished by the simple device of having three of these diagrams or sets of diagonals placed next to each other, as shown in the accompanying diagram, so that a line could be followed readily from one to the other, thus enabling a series of multiplications and divisions to be performed. The diagrams might have been superimposed on each other, but this would make a confusion of lines.

As this same principle of making a succession of calculations graphically may be applicable equally well to other formulæ besides that for wiring, it may not be out of place here to explain the principle before showing how this particular diagram is to be used. The general principle may be laid down that for any formula containing three variable quantities, one of which is the product or the quotient of the other two, the "curves" representing their relative values may always be represented by a series of straight diagonal lines drawn through the centre or zero point. Such a set of lines will therefore enable one to make any calculations graphically for that formula. For instance, horse-power is equal to volts multiplied by ampères; the constant 746 does not concern us at present. A series of diagonal lines properly spaced will therefore give directly either the horse-power, the volts or the ampères, when the other two

namely, the *cross section*. The constant is included in any one of these three sets.

To perform the graphical calculation, simply follow from one scale to the next on the cross-lined background up to the last scale the cross sections, which is the final result sought for. An example is worked out and illustrated by the broken line on the diagram. Starting first with the ampèrage of the particular lamp, .775, on the first scale, follow to the left (see the broken line) to its intersection with the required volt diagonal, 1.0 volt; thence up to the next diagonals, the lamps, 10 lamps; thence to the right to the feet diagonals, 50 feet; thence down to the scale of cross sections, where the reading is about 8,200 circular mils, or about a No. 11 B. & S. wire; the whole operation requiring about as much time as it would take to start the arithmetical calculations.

The relative disposition of the scales is also of importance in such a diagram. For instance, the ampèrage of the lamp is generally the same for a great many computations; it has therefore been made the first scale, so that it can be eliminated from all those computations by drawing a horizontal line, say in red ink, through this value and then starting all the calculations from this line, thus saving that first part of the work. Next to the ampèrage of the lamp, the loss in volts is often the same for many calculations; the volt scale has therefore been made the second one, so that it also may be cut out of these calculations. To eliminate this part, draw a vertical red line through the intersection of the ampère and the volt lines. All such calculations are then started directly from the intersection of this line with the lamp scales. Finally, by the dotted lines drawn through the last scale, as shown representing the cross-sections of the standard wire gauge sizes, the last part of the work is also saved. The only operation left to be performed, therefore, is to follow a horizontal line from the number of lamps to the number of feet; it would hardly be possible to have it simpler. As the majority of calculations are made for the same ampèrage and loss, this represents the most frequent conditions under which the diagrams would be used.

The range of such a diagram can evidently be made very great by having several sets of numbers on the scales, each set being say ten times larger or smaller than the other; the position of the diagonals will remain the same. By an accidental coincidence the position of the dotted lines representing the B. & S. gauge numbers, will also remain very nearly the same for different scales of circular mils, even though they represent different gauge numbers. Furthermore, lamps and feet are interchangeable on the diagram. Although the same diagram may have several different sets of numbers, it is probably preferable to have a separate diagram for each set. A set of three diagrams, of which the accompanying is the first one, will probably cover the usual ranges. For motor currents the same diagrams may be used, by assuming that the current represents that number of one-ampère lamps.

The whole diagram might have been made much smaller by superimposing the three parts over each other, instead of placing them next to each other, the principle remaining the same. The three centres of the diagonals would then be at the three corners of a rectangle. It was thought, however, that this might cause confusion, owing to the great multiplicity of crossing lines, and, therefore, be a disadvantage rather than an advantage.

There exists among many persons, unfortunately for themselves, a prejudice against any graphical methods of calculations. They appear to think that because such methods do not come within the narrow scope of their little multiplication tables they must be something very difficult and complicated, which would take too much time and trouble to master; and that such methods are suited only to professors and college men. In point of fact, graphical calculations are much simpler than ordinary multiplication, and very much simpler than division. Graphical methods share this unwarranted prejudice with other short and simple methods of calculations, such as algebra, the slide rule, logarithms, etc. All such short methods carry their reward with them to such persons, and only to such, as take the small amount of trouble to master them. No one having many and complicated calculations to make will ever regret it if he spends a little time in becoming familiar with any or all of these short methods of calculating; it is his own loss if he does not take advantage of their existence.

Shall "Aluminium" be "Alium"?*

BY OBERLIN SMITH.

Although having the honor of being a member of this distinguished society but a very short time, I take pleasure in accepting an invitation from your committee on papers and meetings to say a few words regarding a proposed shorter and more euphonious name for the beautiful and valuable metal which must, perhaps, now be ranked as base, rather than precious, only because recent metallurgical and electrical science has made such wonderful strides in cheapening its production.

In February, 1890, I had the pleasure of reading before the American Institute of Mining Engineers, at their Washington meeting, a paper entitled "Aluminium in Search of a Nickname." In this essay reference is made to the fact that the nickname "Al" had already been irreverently introduced by many of the people engaged in manufacturing and selling it, in accordance, obviously, with the general tendency of our modern rapid life to condense all our commercial nomenclature into as small a compass as possible. In witness of this we, in America, as well as many of the denizens of other English-speaking countries, have generally adopted the word "wire" as a substitute for "telegraph," and have, by successive stages, shortened the term "elevated railroad" into "elevated road," "the elevated," "el" and finally "L"—the latter being spelled as briefly as possible by the ingenious device of using only one letter.

In accordance with this labor-saving tendency in regard to our tongues and pens, it certainly seems desirable that a shorter name than "aluminium," or even "aluminum," should be found for a metal which is destined to be so largely used in the further evolution of our modern mechanical life, and probably not a little in the electrical engineering of the future. In the paper before mentioned reference is further made to the fact that the names of the commercial metals now in use are nearly all short, crisp words of one syllable, as gold, tin, zinc, lead, bronze, brass and steel, while the most common two-syllabled ones, nickel, silver and copper, are also simple and easily spoken.

In further arguing the point regarding aluminium, I suggested as possible future names "aluum," "alium," "alim" and "alm," as being suggestive of the original word for which they might become substitutes, and yet euphonious and easily pronounced. Since the essay in question was printed my proposed reform has attracted considerable attention in the technical papers, the general preference appearing to be for the word "alium" rather than for the others mentioned. This word has also been suggested independently by no less eminent a scientist than Prof. Elihu Thomson, who did not know that I had already proposed it. It has been heartily indorsed by Mr. Eugene H. Cowles, a well-known authority upon this metal, in an article in the New York *Tribune*, and Mr. T. Commerford Martin, past president of this society, in the columns of the *Electrical Engineer*.

Upon thinking over the matter further, I myself prefer this word to the shorter ones suggested, alim and alm. The latter, as Prof. Thomson suggests to me, reminds one of alms-giving, and I think the former looks and sounds too much like "alum." It is true that "alium" has three syllables, but they glide so smoothly into one another that it is scarcely harder to pronounce than the shorter ones mentioned, while being much pleasanter to the ear; and, as Mr. Cowles states in his interesting article, it agrees in its termination with many other words used by the chemists to signify metals—as, *e. g.*, sodium, calcium, etc. Very probably these same chemists would consider it appropriate to use the word "alia" for the oxide now called "alumina." I do not feel sure about the desirability of this, but cannot, at this speaking, see any objection to the word.

It is earnestly to be hoped, if we are ever to have a shorter name than either of the two present ones, that some decided step will soon be taken by the proper authorities, if their existence and identity can be determined, to establish, once for all, a shorter and more convenient name. If the leading technical journals in this country and abroad could be induced to agree upon the word "alium," or something better, if such can be suggested, and if, furthermore, the national engineering societies should see fit to indorse the same, the work of reform would practically be accomplished, as it is not probable that those who are strictly scientists only would hold out against a popular verdict of the kind mentioned.

Possibly a practical method of starting this reform would consist in one of the societies mentioned (and why not this one?) appointing a committee to distribute an argument of the case among the editors of the various technical journals, here and abroad, asking for replies as to how many of them would be willing to adopt the new word, should a majority of the whole number agree. This committee could also send communications to the other national engineering and scientific societies, requesting action, or, at any rate, an expression of opinion, upon the same subject. If each society proved willing to appoint one or more members upon a joint committee of conference, a favorable report by such a committee, especially if backed by the technical journals, would undoubtedly command sufficient respect to lead to the adoption of the name in question by the societies themselves at a later period.

If we consider the length of the names "aluminium" and "aluminum," in comparison with other elements, we find that the former is the only five-syllabled one extant. In a list of 64 elementary bodies we find only 18 of them to be words of four syllables, while 29 have three syllables, 11 two syllables and five one syllable, the latter all happening to be ordinary commercial metals. The question naturally arises, can we afford to put a material which is probably destined to such extensive use as is this comparatively new and beautiful metal in the category of these rarely used and many-syllabled elements which, as has been seen, are in a small minority of the whole number? Can we, moreover, afford to let it stand alone in the whole list of elements, as the only one (excepting, perhaps, mercury, which foolishly has a sort of synonym) possessing *two* distinct and interchangeable commercial names, as is now the case?

In enunciating the words in question, we find that although they are somewhat musical in sound, especially the longer one, they are not easy to speak rapidly, especially by a person not in the habit of pronouncing them frequently. In writing them the evil is worse, for in the case of "aluminium" one must, to be sure one is right, analyze and count some 28 nearly similar up and down strokes of the pen after writing "Al." Otherwise, there is apt to be a "u" or an "i" too many or too few; and even if they are right, some discretion is required in ascertaining where to dot the "i" and the "i." If the casual reader does not believe all this, he is only invited to try it as often as has the writer.

In regard to the interest of this very progressive society in the improvement and development not only of aluminium, but of its name, I think there can be no question, as it is a metal which is already used to some extent in the electrical arts and is destined to far greater use as it becomes cheaper and as new inventions are made for applying it. Especially is this the case in view of the recent discoveries in France regarding certain alloys of aluminium with small percentages of copper, which show that we can double its tensile strength while increasing its weight only about 6 per cent. I have not heard how its electric conductivity is affected by such alloying, but if these stronger metals shall prove to be nearly as good conductors (and possibly they may be better) than is the pure metal, we at once have a bright vista opening before us for telegraph and telephone line wires, of great conductivity in proportion to their weight, combined with durability and beauty. There are doubtless numerous other applications of the metal and its alloys to be developed in the near future, especially in electric railroading, where strength combined with extreme lightness is destined, I think to be secured by materials and methods the use of which will, even in this generation, produce a speed and safety of which we, as yet, can scarcely dream. In this abolishment of the old "dead weight" system—this destruction of the cars of Juggernaut, so to speak—in which the electrical engineer is to bear so brave a part, shall we know one of the most useful materials of the new age as aluminium, aluminum, or alium?

* A paper read before the American Institute of Electrical Engineers, May 21, 1891.

The Practical Aspects of Electric Welding.*

BY FREDERIC A. C. PERRINE, D. SC.

It is hardly necessary to give any description of the general process of electric welding to the Institute of Electrical Engineers, or to follow Mr. Lemp's paper of last year† and our interesting visit to the factory of the welding company, with a detailed description of the machines. I intend rather to speak of them in their actual use, and to discuss some of the problems involved.

The plant with which I have been intimately connected, though not one of the heaviest is still one making a great number of successful welds in a day, and is one in which the joints are required to be of the highest character and are subjected to the severest tests. The first machine actually sold by the welding company was bought by the Roeblings, but on account of the delay of the engine builders it was not in place and running for some six months, three or four months after other machines were in satisfactory operation. This was of the direct type, having a double winding on the armature, and the welding done on an apron immediately above the collector terminals of the heavy alternating coils. The pressure was applied by a handle regulated by the workman, the projection also being regulated by a scale stamped on the cam of the handle. Though considered crude, this machine did satisfactory work, often for twenty-four hours a day, and six days in the week, for about two years, having made about 370,000 splices in telegraph wire during its useful life.

After the automatic machines were brought to a reasonable perfection we purchased a generator capable of welding up to half inch copper (40,000 watts), and installed one large transformer and seven smaller ones of a capacity from No. 4 B. & S. copper to No. 18 B. & S. These have been at the works something less than one year, and show a daily record of over 1,000 welds in copper and iron wire.

Our attention was drawn to the process at first as a possible solution of a very troublesome problem in preparing and packing iron telegraph wire. For the convenience of the telegraph companies this wire must be put up in bundles, measuring each exactly one-half mile of continuous length. It is very easy to say that the proper weight billets should be bought, and the pieces kept continuous through all the processes of manufacture, but as a fact these pieces are necessarily irregular in original size, and are often broken in the process of manufacture, and, in consequence, it has long been the custom to make the proper weight bundles by re-coiling and splicing with the common telegraph or Lippman's joint, after the wire has been galvanized, jointing before galvanizing having proved a failure on account of the acid carried over into the zinc pans by the great helix of the joints.

Singularly enough, the telegraph companies which had for so long accepted as satisfactory these cumbrous connections immediately commenced to complain of the large burr left by the welding machine, and which we had thought it unnecessary to remove. An emery wheel solved this difficulty, however, and we were then able to defy

* A paper read before the American Institute of Electrical Engineers, May 20, 1891.

† See THE ELECTRICAL WORLD, June 7, 1890.

them to find the joint at all. After a very complete series of tests on the joints themselves, the telegraph companies have been finally satisfied, and we are now able to make our bundles of the proper weight and length before the galvanizing is put on, and thus save one rehandling of nearly our whole product, besides having removed one of the greatest difficulties and causes of complaint.

"Shorts," as they are technically termed, in copper are, of course, a still more serious source of loss, not only on account of the greater value of the material, but also on account of the greater liability of this weaker metal to break in the process of drawing, and also on account of the necessarily defective character of a joint in the insulation with which copper wire is usually covered when sent out from the factory. Cables, as you all know, must be made in exact lengths, many of which are often very great, and though a twisted soldered joint might be satisfactory at the bottom of the sea, or covered by a lead sleeve in a manhole, it could not for an instant be tolerated in the body of a cable which must, before completion of the cable, be passed through exact dies for covering with rubber or lead. Before the introduction of these machines, our custom had been to carefully scarf and fit the joint, which was then brazed with silver solder. While this method makes a strong joint, but little increased in resistance, and thoroughly satisfactory in other respects, it has the disadvantage of being rather slow and difficult to produce, on account of the necessary care in fitting the scarfed ends as well as in soldering and finishing.

Since last November three boys on three machines have made respectively in this work 10,570 welds, 7,642 welds and 20,421 welds, the registers having been taken on April 16. Every weld is tested by bending and straining, and if one shows any weakness it is quickly cut out and made again, with the loss only of a very small amount of time and the royalty to the welding company. In all of our welding of sizes below one-quarter inch the ends are prepared by cutting square across with a pair of pliers, and then setting the cuts at right angles to each other, touching only at the centre from which the heat radiates to the surface, then, after completion of the weld, the burr is removed by an emery wheel from the iron wire, and by a file from the copper. The preparation and finishing is a little more complex in the larger sizes, the ends are filed to a true butt and chamfered at the edges, and after a reheating in separate clamps the burr of the weld is forged to the diameter of the original rod. The necessity of this will be apparent later on. All of this work is done on either soft steel or copper wire, and is probably of the simplest character done on any machines made by the welding company, consequently the advantages are not so apparent as where the welds are difficult in character on account of complicated shapes.

More varied work is done by the companies of whose plants I now give a slight description as likely to prove interesting.

Messrs. Seward & Son, of New Haven, Conn., have at work a machine of somewhat universal character, its employment being principally in uniting Norway iron to Swedish steel, in such shapes as are required in carriage irons and fifth wheels. In this work the burr is removed by a drop hammer at the same heat by which the weld has been made.

The crescent tires of the hundreds of bicycles manufactured by the Pope Manufacturing Company, are welded and afterward formed by dies at the same heat. The material is soft steel. These people also have a machine for brazing their small parts.

Besides using the electric welding machine for its telegraph wire, the Trenton Iron Company, of Trenton, N. J., has boldly attempted to make a weld in a wire rope to avoid the tedious, and, with its locked wire rope, impossible operation of splicing. The ordinary joint in a wire rope is from 10 to 20 feet in length, and requires considerable skill on the part of the splicer and his assistants. The operation is to re-twist bunches of wire from opposite strands, and to tuck the loose ends under the adjacent complete strands, which then hold them in place. With the locked wire rope, which is itself but a single strand, the only successful method of joining opposite ends has been to fasten securely around each a cast-iron collar, and after abutting the ends in a welding machine, to cement the whole together, and afterward to break off the cast-iron collar, leaving the rope as a solid bar for about two inches at the weld.

Among the new solutions of old problems accomplished by the electric welding process, is that of the manufacture of spinning rings by the Hopedale Machine Company, of Hopedale, Mass. The desideratum of these rings is a uniformly hard surface, to produce which the method has been to stamp the ring from a sheet of metal, and after finishing in a lathe, to case-harden the whole, involving, as one would naturally see, the loss of a considerable proportion of the original sheet. With a welding machine it is possible to form these little rings, about 2½ inches in diameter, from a piece of bar iron, and after the burr has been reduced by a series of dies, to finish as before, with the result of a decreased cost and an equally satisfactory product.

One of the largest and most complete plants at present in operation is that of the Studebaker Bros.' Manufacturing Company, of South Bend, Ind. This plant has at present nine machines; one of them for steel axles up to 1¼ inches square. After the weld is made it is quickly removed to a drop hammer making about 300 blows a minute, then at the same heat the axle is set ready for the market. The test for these axles is to bend to 90 degrees while hot, and then back to alignment. No instance has yet been reported of an axle breaking under this test, which is frequently made to insure perfect workmanship.

This plant has two machines for welding large car tires, about 4 inches wide and ¾ inch thick, and smaller sizes. The weld is made in the usual way and then quickly removed to a hammer, where, by vertical and side blows, the burr is quickly removed. One hammer will easily take care of two welders in constant operation. The plant also has one machine for small carriage tires, 1 inch × ¼ inch, and smaller sizes. In this case the burr is removed by one blow of the hammer, after which the tire is set cold by a machine called a cold stover, which embraces the tire on all sides, and by great compression sets it up to the felloe more quickly and as effectually as can be done by shrinking in the old method; this, of course, is an immense strain on the weld, being a compression beyond the elastic limit of the metal. The plant has two machines for the hub bands, which are used on the wagon wheels, and is able to turn out about 1,200 on each machine; besides these there are two or three machines for smaller miscellaneous work. All of the metal used by them is either iron or low grade steel. After the introduction of the plant, the machines made 360,000 welds inside of six months.

Probably the heaviest work done at present in electric welding is that of the Johnson Rail Company, of Johnstown, Pa., which is, as stated in the journals, welding long lengths of rails together, since with the continuous mill the company already rolls a rail too long to ship, but economy is found in the process in some details of the smaller manufactures. As to the results, the company says: "We would state that over a year ago we put in one welder for general work. The bulk of the work done on this machine was work we had totally failed to do by hand welding, not on account of the difficulty of the weld, but on account of the general unreliability of the result. The result of a year's use of the electric welder was, that we have not known one of the welds made by the method to fail, and we have closed contracts with the welding company for four 40,000-watt machines and two 80,000-watt machines, with the intention of adopting the method extensively in our works."

Agricultural machinery has generally been furnished with iron wheels, consisting of a malleable iron hub into which the spokes are upset, and of a rim into which they are upset at the opposite end. The electro-welding machine has given us two new wheels, each of which are supposed to be preferable to the one described. In the first, manufactured by the Electric Wheel Company, of Quincy, Ill., the hub is cast of malleable iron, with spokes about 3 inches long. To these are welded, by one machine, wrought iron spokes, and, again, by another machine, these spokes are upset into the rim, which is itself welded into a tire, the product being a wheel of which the spokes are less liable to rattle loose at the hub. The second method is that of Niles & Scott, Laporte, Ind. The hub in this case is composed of two drop forgings of low grade steel, grooved to receive the spokes; one half is placed on the base of the welder, and the spokes laid in their grooves, then the other half of the hub is put on and the clamp brought down. The current is then applied, and the whole, spokes and hub, welded solidly.

The Rogers Typographic Company, Cleveland, O., is practically welding brass to steel, making as high as 800 welds per day, and thus effecting a great saving in the manufacture of its type-setting and founding machines.

The hardest steel at present successfully worked by this process is in the welding of band-saws by the E. C. Atkins Company, of Indianapolis, Ind. Besides the regular work of making the joint in continuous band-saws, these people have ingeniously adopted this method for replacing broken teeth in finished saws. Formerly they were compelled to cut down to a smaller size any saws from which one or two teeth had been accidentally broken, thus losing not only the difference in price between the two saws, but also the entire cost of labor in cutting the original saw. At present when a tooth is broken out they fit in it a new tooth which is electrically welded in place, and a drop of oil applied at the completing of the heat restores the temper to a serviceable point. This, one can readily see, is of the greatest value in reducing one of the sources of imperfect work.

Pipe welding, which we all saw successfully accomplished at the factory last year, is put in practice by the Pennsylvania Railroad Company, as well as by the Columbus Iron Works, Columbus, O.; Blymyer Ice Machine Company, Cincinnati, O., and the Electric Pipe Bending Company, of Newark, N. J. This latter company is engaged principally in manufacturing long continuous coils for ice machines, blast furnace tuyeres, and radiators. With this machinery it not only welds extra heavy black pipe, but also electrically heats the pipe with a machine 20 inches between the clamps for the purpose of bending to desired shapes over pipe formers.

With continuously spiraled coils of pipe it has been necessary for a smith to weld the whole length, 150 to 200 feet, before attempting to bend any portion of it, and then after once the bending operation has commenced, in order to get a uniform spiral, the heat is not altered or the bending operation suspended till the coil is complete. Under the present electrical methods the coils are continuously heated in a fire, and the coiling is continuous while one length of pipe is welded at a time, the operation being to attach the welding machine to the end of the moving pipe, and while the forward portion is undergoing the process of bending to weld on a new length, which will be accomplished in a sufficiently short time not to interfere with the coiling apparatus. In all of this pipe welding the burr is beaten down by means of a pneumatic hammer, which is put in rapid motion by the act of closing it around the pipe, a rapid hammer having proved much more effectual than any press or dies. This is probably on account of the more rapid cooling action of the press, since no forming is attempted before the weld is completed and the current is turned off.

Three types of machines of importance are soon to be in use for the purpose of our army and navy, and the early recognition of the importance of this method of manufacture speaks well for the ingenuity of our government designers.

In the new wire-wound guns one of the most important specifications for the wire was that it should be readily jointed by the electric welding process, and in the Crozier gun now constructing the wire will be wound in one continuous piece under a constant and heavy strain. This wire is one-tenth inch square, with 180,000 pounds breaking strength, and 100,000 pounds elastic limit, tinned as lightly as possible. The gun is to be made by winding the wire over a steel tube and shrinking a ring over the whole, for the purpose of longitudinal strength; the welding process is simply the same as that described for round wire, and is reported as having given satisfactory results.

For the Charlestown Navy Yard there is about completed a machine for welding ship chains up to two inches diameter links. These links are formed in halves and fitted roughly to each other, the welds being made in both sides at once by the same heat, which can be regulated to force either side at the will of the operator. When completed, both welds are forged immediately in a die by the same hammer. By this method only the points to be welded are heated, and, as these are immediately forged, one could expect from the process a nearer approach to the strength of rolled metal than where the whole link is heated in the ordinary fire to a welding temperature.

The latest development for government work is the manufacture of conical shell and shrapnel for the smaller armor-piercing guns. With the modern types of armor a cast shell is not of sufficient strength to resist the shock of impact, and in consequence a chrome-steel point is welded to a tool-steel body, embracing the powder cavity. This latter is but small in comparison with that in the old round shell of revolutionary days, consequently the accurate forging of the interior becomes correspondingly difficult.

Cast shells are made from the higher grades of crucible steel, but with these the casting is both difficult and uncertain, necessitating a large amount to be allowed for machining to a uniform wall in the probable case of a decentered core. The electrically welded shells are made entirely of forged point, body and base, which may be finished to approximate dimensions, these requiring after welding a minimum amount of machining. The tests on these shells have resulted in a contract for a large number under a guarantee of the manufacturing company.

This brief sketch of the representative uses of the process, I have given not only to show the practical applications of electric welding, which are undoubtedly interesting in themselves, but with this introduction I wish to call attention to some of the limitations and necessary precautions, as well as to the light which the results of this method of applying heat to the metals throws upon some of the obscure and disputed points of structure and constitution.

Welding in the ordinary sense on an anvil by means of a forge is essentially the uniting of two surfaces of a metal which has previously been rendered plastic, and which, under the hammer, can be made to intermingle into a structure similar or identical to the original metal; in consequence, this can only be accomplished with materials capable of passing into a plastic state before actual melting takes place. One of the most familiar examples of this weld to electrical men is the common splice in the gutta-percha core of a submarine cable. Provided only that the surfaces are clean, it is possible to make this material unite as perfectly as before it was cut. Amorphous waxes and similar substances can be treated by a like method, but when we reach truly crystalline materials it is no longer possible to effect this union below the melting point, unless great pressures are applied. In passing from the one to the other condition, we see the phenomenon of the familiar cementing of ice under pressure great enough to produce what is called regelation.

Now, viewing the metals in the light of these simple examples we find that it has long been possible to weld amorphous iron under moderate heat, but for the highly crystalline steels and other metals a pressure high enough in ordinary practice has not been available.

Welding cold has been accomplished in a most striking manner by Prof. Spring, of Liège. Using small cylinders filled with powders of highly crystalline metals, he has not only succeeded in compressing them into compact bars, but has also succeeded in making alloys with all the character-

istics of the same alloys produced in the usual manner in a crucible. These results go very far toward proving the absolute possibility of a weld in any material, however fibrous or crystalline. The electric welding process uses rather the method of the crucible than of the press, for although considerable pressures are applied during the operation, they are not beyond the limits of ordinary forging, and the essential difference is the greater heat available at the direct point where it is most needed, a heat which approaches and often reaches the melting point of the material. As the pressure is applied it is transmitted by the cold bar directly upon the softened metal and forces it to unite more readily. This view of the process brings us at once to some of the most important limitations: cast iron, cast steel, cast copper, cast brass, are not changed in their essential constitution, but are united by a weld having all the characteristics of the original bar. Now let us take a bar of rolled zinc or drawn copper and compare it with the cast metal. We find the crystals, formerly large, and widely separated, especially in the case of zinc, where often internal oxide stains are perceptible, now are broken into minute fragments, elongated and united so closely as to allow the greatest opportunity for the action of cohesion. Weld such a metal as this, and the joint where broken will immediately show a rearrangement of the particles into larger and looser crystals similar to those of the unworked metal. By repeated fracture of the bar, you will be able to follow graduations of the action till it loses itself.

A weld of this character will give a sufficient tensile strength, but the brittleness of a coarsely crystalline material has returned. Whether such a joint is worthless is entirely a matter of circumstances. With small sections the action is not perceptible on account of the very small length heated, and also because bending, however short, does not subject the metal to so great a strain as is the case with the larger sections. For a rod to be subjected to further drawing, rolling, or other like processes of manufacture, the weld is satisfactory, since the subsequent working reinstates the metal in its best condition, but for a wire to be considered a finished product further manipulation is necessary. In view of this, the later machines for welding heavy copper have been provided with reheating clamps and light rapid hammers, by means of which the burr, after a slight trimming, can be reheated and forged; in special cases a further hammering cold is added. Though this produces a great improvement in the metal, it yet leaves a good deal to be desired where great strength and pliability are required. To produce this, a further upsetting of the metal throughout the whole heated space and a subsequent forging will be necessary. This, up to the present time, has not been provided for, and presents a greater difficulty than is at first apparent, besides furnishing a new proof of the crystalline constitution of copper. On account of this characteristic, as is apparent on attempting upsetting in the welding machine, it offers, at a red heat capable of moving and rearranging the particles, a resistance so high to compression that three or four times the pressure necessary for welding will not have the slightest effect toward increasing the diameter or upsetting. With bronzes the further difficulty is encountered of red shortness between the molten temperature of the weld and the malleable red temperature. That this should be so necessary and offer so many difficulties may seem strange, since the metal does not apparently exceed the temperature of ordinary annealing, and it must be that either the passage of the current by an extra disturbance helps to rearrange the particles, or else the temperature is greater than we imagine from an observation. The latter explanation seems to me to be the more likely, since our ordinary observations are made on metals heated from an external source, and of which the surface is at the highest temperature. With the weld, however, the source of heat is internal, and the surface is undergoing a continual cooling from the external air.

Welds made in the higher carbon steels are at a similar disadvantage, and must be looked upon with disfavor unless provision for upsetting and forging hot is provided. These disadvantages are especially apparent with steel wires of the highest grade, where the strength of the original material has been more than doubled by tempering and drawing. In such cases it is not ordinarily the loss of tensile strength that is to be feared, but the increased liability to snap under repeated bendings. This is especially important in the case of wire to be twisted into a running rope such as is used on our cable railroads. From this view, the weld in a whole rope, where forging is impossible, would be necessarily defective, and though for a standing rope I have no doubt it would be fairly successful, yet for a running rope I believe everything tends to prove it dangerous. It has been suggested as an explanation that these effects are due to the presence of oxygen at the weld, producing suboxide in copper and reducing the carbon in steel. In support of this view the case of the application of oil to the hard saw teeth is cited as supplying the necessary carbon by its decomposition. It is undoubtedly a fact that by the heating of these high grade steels, and subsequent slow cooling, some of the combined carbon is changed to the graphitic form, with a consequent loss of strength, and it seems clear to me that a drop of oil at the right moment serves to restore this, or, in other words, effects a tempering. It is almost useless to attempt an explanation by a complicated chemical decomposition, when the simpler molecular rearrangement is more in accordance with the facts and a more complete explanation.

This brings us to a point where the electric welding throws light upon the actual production and nature of burnt steel. By forcing the heat in welding, no matter if rapidly, this effect can be produced as thoroughly as by the means of a fire, while if the name "burnt" was an accurate description, and the iron and carbon oxidized, a sufficient time would be necessary for its penetration into the centre of a bar of metal. This agrees and is a further confirmation of the most modern ideas about burnt metal, that it is a molecular rearrangement, and by careful forging and heating the metal can be restored to its original state. In this case oxidation certainly does not take place, though the action may be similar to metamorphism in rocks, steel being at the present day looked upon as a mineral, a matrix of iron, including minerals which are generally compounds of iron with carbon, silicon, sulphur, manganese or phosphorus. Under this view there may be internal chemical rearrangement at high temperature. With carbon we know this to be the case, but I take it as settled by electrical heating that the change is not necessarily an oxidation.

The welding of two different materials, such as iron and steel or malleable cast iron, presents another difficulty and possible danger. When such a weld is broken we find that the pressure in the plastic state has forced the iron over the steel or malleable, which has itself been merely slightly melted and cemented to the adjacent particles of the iron. This produces what might be called a reverse riveting, the hot iron having been upset over the steel and enclosing it tightly, in the place of having been upset in a hole, as in ordinary riveting. Again, as in all this work, the tensile test is but a poor test of quality, and though a weld may have within ten or twenty per cent. the tensile strength of one of the original materials, it is a fallacy to say that therefore the weld is within ten or twenty per cent. of the quality of either of them. Use here again determines the serviceableness of the process.

I am tempted here to carry further the discussion of the special cases offered, but it would only be to apply over again the observation indicated in the foregoing, and which might be finally stated that, although the electric welding process will not practically splice everything from a bar of magnesium to a steamer shaft, yet it enables us to accomplish results otherwise impossible, and if both the use of the product and the treatment of the materials be sufficiently studied, it may be trusted in its results.

Report of the Council of the American Institute of Electrical Engineers for the Year Ending May 19, 1891.

Your Council takes pleasure in reporting that the work of the Institute has been continued during the past year with most gratifying results, in the growth of membership as well as interest on the part of all who are identified with it.

Ten monthly meetings of Council have been held, at which the average attendance has been nine.

Ten meetings of the Institute have been held besides the annual meeting, at which 25 papers and reports were read and discussed. These have been printed and distributed to the membership.

Committees of the Institute have reported upon a standard resistance of copper and the adoption of American names for electrical units. The reports of these committees have been widely circulated and have met with general approval.

A standing committee of five on units and standards has also been appointed.

On the 1st of June the Institute entered upon the arrangement referred to in last year's report, by which the meetings of the Institute and of the Council have been held in the House of the American Society of Mechanical Engineers, where the secretary's office is also located. The quarters have proved entirely satisfactory, and in accordance with the terms of the lease the same arrangements will be continued for the coming year.

The total membership at the close of last year's report was as follows:

Honorary	2
Members	145
Associate members	280
Total	427

There have been 124 associate members elected during the past year.

The following members have resigned during the year: G W. Hebard, C. L. Healy, E. H. Johnson, R. W. Blackwell, Leopold Weil, S. M. Plush and Hartley Gisborne; total, 7.

We have lost by death the following members: William B. Knight, of Kansas City, Mo., and Thomas P. Conant, of New York City; total, 2.

One member has been dropped from the roll.

The total membership is now as follows:

Honorary	3
Members	161
Associate members	377
Total	541

SECRETARY'S BALANCE SHEET FOR YEAR ENDING MAY 19, 1891.

Ralph W. Pope, Secretary, in account with the American Institute of Electrical Engineers.

Dr.		*Cr.*	
1891.			
To Balance from 1890	$2.23	By cash to treasurer	$5,717.45
Sundry receipts	12.23		
Entrance fees	565.00		
Life members	200.00		
Back dues	85.35		
Current dues	3,921.14		
Advance dues	203.33		
Electrotypes sold	222.35		
Typewriting and stenography	217.53		
Transactions sold	270.00	Secretary's balance on hand	10.51
For binding	28.80		
	$5,727.96		$5,727.96

EXPENSES OF THE YEAR.

The treasurer has disbursed upon warrants drawn by the secretary, by direction of the Council and Finance Committee, the amount of $5,213.77, which has been expended as follows:

Stenography and typewriting	$330.37
Stationery and miscellaneous printing	400.17
Postage	311.14
Messenger service	34.99
Salaries	1,475.00
Engraving and electrotyping	454.33
Meeting expenses	88.00
Rent	773.00
Printing transactions	1,112.47
Express	2.90
Moving	17.00
Telegrams	3.35
Gas	10.49
Binding	87.72
Office fittings	70.45
" expenses	32.79
Copyright	7.00
Duties	.75
Cartage	1.85
	$5,213.77

This amount should be credited with the sum of $738.68 appearing in the receipts, for cuts, copying, sales of Transactions, etc.

The net receipts for the year for membership fees and dues are therefore $4,974.82 and the net expenses $4,475.09, leaving an excess of receipts over expenses of $499.73. The outstanding bills against the Institute amount to $323.65, and the uncollected bills due the Institute from others than members amount to $334.67. The arrearages of dues for the past year amount to $480. The balance in the treasurer's hands to the credit of the general fund is $752.94, showing an increase of $503.68 over last year.

Respectfully submitted by direction of Council.

RALPH W. POPE, Secretary.

A Photographic Study of the Electric Arc. Based upon Experiments Made by Mr. J. C. McMynn.*

BY EDWARD L. NICHOLS.

At the last general meeting of the Institute, Mr. Louis B. Marks read a paper on the electric arc, which dealt with the performance of commercial lamps in the continuous current circuit. The present paper is a preliminary report of a similar line of work now being carried on under the writer's direction by Mr. J. C. McMynn, he subject of the investigation being the alternating current arc. When the research in question is completed, Mr. McMynn will publish the results in full; but, since his report may not be ready for several months, it seemed desirable that I should lay before the Institute at this meeting certain points which have already been established.

The alternating current arc and the continuous current arc afford two entirely distinct fields of investigation. Candle-power, distribution of light, quality of light, temperature, efficiency, resistance, electromotive force necessary to maintain the arc, performance of the carbons under varying conditions; all of these are questions concerning which we have abundance of experimental data, so far as the continuous current arc is concerned. In the case of the alternating arc, however, these and many other points are still to be determined.

The arc lamp, fed by alternating currents, invariably hums and sings. The note, which is not to be mistaken for the hissing which we hear from continuous current lamps that are burning under improper conditions, possesses a definite pitch, determined by the alternation of the dynamo. That the note is not due to the mechanism of the lamp is itself readily shown. The Jablochkoff candle, which is devoid of all mechanism, sings as merrily as the lamp with solenoid regulator; any form of hand lamp will do the same. I do not remember having seen any definite statement concerning the source of this humming noise, nor any satisfactory discussion of the question. My attention was first brought to the very obvious explanation of the phenomenon by the study of certain curves of electromotive force, obtained by Messrs. Archbold and Teeple, in the course of an investigation of the alternating discharge between a ball and point.† These curves have recently been published. I reproduce one of them for the purpose of elucidation.‡ This curve was obtained by the well-known method of instantaneous contacts. The circuit under investigation was the high-tension secondary of an induction coil, actuated by an alternating-current dynamo, the E. M. F. of which followed the law of sines closely. In the circuit were placed a ball and point, the air space between them being such that the discharge would take place in one direction only, from ball to point. It was established by the use of a revolving mirror that an arc existed only during that

*A paper read before the American Institute of Electrical Engineers, May 20, 1891.

† See Archbold and Teeple; Thesis in MS., Library of Cornell University, 1889.

‡ See "The Alternating Electric Arc between a Ball and Point. *American Journal of Science*, Vol. 41, p. 1.

part of each cycle represented by the horizontal portion of the curve. [*a*–*b*, Fig. 1.] Shortly after this curve had been obtained the curves of Messrs. Tobey and Walbridge, illustrating the performance of the Stanley arc lighting dynamo, appeared.* It will be remembered by those who heard their paper read before the Institute § that this machine, which gave very nearly the sine curve of E. M. F. when working through non-inductive resistance, showed curves very widely removed from that form when arc lamps were in the outer circuit.

Fig. 2 contains the curve of the arc lighting machine when five lamps were in circuit. The relation of this curve to those obtained with the ball and point is evident. Here, also, the variation of the curve from sinusoidal form is to be ascribed to the periodic formation and breaking down of the arc, which happens twice in every complete cycle, instead of once, as in the case of the "one-way" discharge of the ball and point phenomenon.

After studying these curves it seemed to me unquestionable that the humming of the alternating arc is due to the rapid periodic extinction and re-establishment of the discharge, the effect being similar to that observed in singing

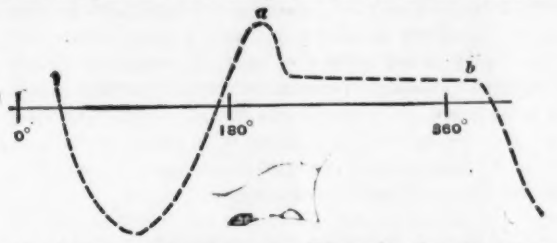


FIG. 1.—FROM ARCHBOLD AND TEEPLE'S THESIS ON THE "BALL AND POINT" EFFECT.

feature; whereas the *actinic* image of the arc far exceeded in intensity that of the carbons.

These photographs establish the intermittent character of the alternating arc beyond question. They also exhibit in a new light many interesting properties of the arc, some of which are already well known, while others have not been adjusted, a sensitive plate was driven past the aperture at high speed. The photographic image differed from that observed in the revolving mirror chiefly in the relative brightness of the arc proper, and of the incandescent carbon of the points. To the eye, the latter is the dominant ness and of light is also seen to vary greatly under conditions not yet determined. Fig. 6 represents the highest rate of speed given to the plate in any of these exposures. The image of a single alternation was in this case extended almost across the plate. No new features were brought to light, however, by this process of magnification.

Figs. 7, 8, 9, 10, 11 and 12 were obtained by driving the plate vertically through the field, parallel to the carbons. An unlooked-for feature of all these plates was the oscillation of the arc from right to left in synchronism with the alternation period. Mr. McMynn suspected this vibration to be due to the action of the earth's magnetic field.* He was able to verify his view by comparing photographs made with the camera placed with its optical axis in the meridian with others in which the arc was viewed from the east or west. The disturbance was more marked in the former position and disappeared almost entirely from negatives taken in the latter. This point is well illustrated by Fig. 8 (*A* and *B*), which shows the image obtained from the north and from the east. The lamp in this case was supplied with cylindrical carbons. All the other photographs represent the arc between flat carbons. In a strong

Fig. 7 a.

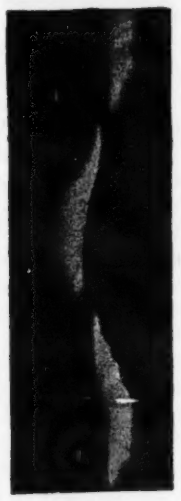


Fig. 7 b.

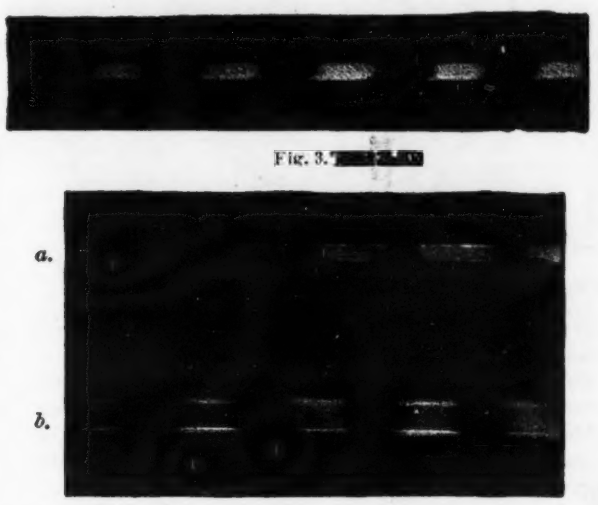


Fig. 4.

Fig. 9.

Fig. 10.

Fig. 8 a.

Fig. 8 b.

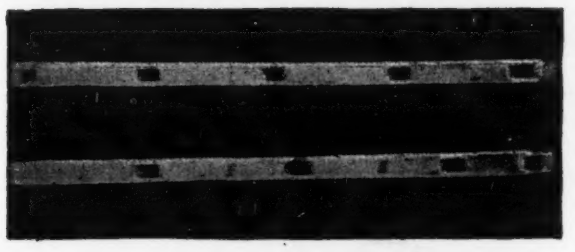


Fig. 5.

Fig. 6.

Fig. 11.

Fig. 12.

PLATES ILLUSTRATING PROF. E. L. NICHOLS' PHOTOGRAPHIC STUDY OF THE ELECTRIC ARC.

Fig. 3.—Alternating arc. [Movement of plate horizontal.] Fig. 4.—Alternating arc. *a*. Short arc (43 volts). *b*. Long arc (58 volts). [Movement of plate horizontal.] Fig. 5.—Alternating arc. [Movement of plate horizontal.] Fig. 6.—Alternating arc. [Movement of plate horizontal.] High speed. Fig. 7.—Alternating arc. [Movement of plate vertical.] *a*. Showing oscillations due to earth's field. *b*. Showing oscillations in a stronger field. Fig. 8.—Alternating arc between cylindrical carbons. [Movement of plate vertical.] *a*. Arc viewed from north showing oscillations due to earth's field. *b*. Arc viewed from west. Fig. 9.—Alternating arc. [Movement of plate vertical; arc in strong magnetic field.] Fig. 10.—Alternating arc. [Movement of plate vertical; arc in strong magnetic field.] Fig. 11.—Alternating arc. [Movement of plate vertical; arc in a strong magnetic field.] Fig. 12.—Continuous current arc. [Movement of plate vertical; arc in strong magnetic field; arc flaming.]

flames. When, some months later, opportunity was found of viewing the image of the arc of an alternating current lamp in the revolving mirror, I was prepared to witness the extinction of the arc during a definite part of each alternation. I do not know whether any member of the Institute has tried this simple experiment. I have seen no description of it anywhere, although Wiedemann mentions the application of the revolving mirror to the study of the continuous current arc,† and Joubert‡ (1880) makes brief mention of a very ingenious application of the plenakistiscope to the study of the changes to which the alternating arc is subject, during each period. When such a mirror, mounted upon a vertical axis, is set up at a convenient distance from the lamp, the images of the white-hot tips of the upper and lower carbons are drawn out by the revolution of the mirror into uniform, parallel bands, extending quite across the field of view. The intervening narrow strip, much darker, is the image of the arc itself. This region, however, is not uniform. It consists of alternate patches of purple and black, which mark the intervals during which the arc exists and is extinct.

Mr. McMynn's first step in the investigation which it is my purpose to discuss in this paper was to photograph the arc under conditions which would bring out this phenomenon. A camera with long bellows was set up near the lamp, the distances from plate to lens and from lens to lamp being such as to give a somewhat enlarged image of the arc. In the focal plane an opaque screen was mounted, which contained an opening just large enough to receive the image of the carbon points. The apparatus having been noted. Of the many negatives already obtained, a few characteristic forms are given in the accompanying plates.

Figs 3, 4, 5 and 6 show the results obtained with plates moving in a horizontal direction, at right angles with the axis of the carbons of the lamp. Fig. 3 is an enlargement of one of the first negatives taken. The speed of the plate was moderate, the size of the image smaller than the arc

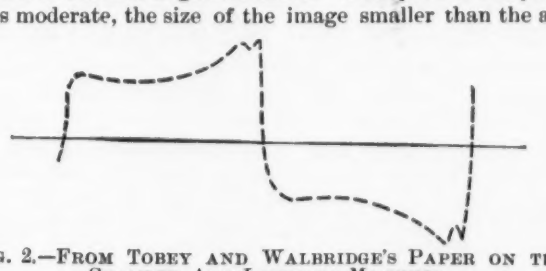


FIG. 2.—FROM TOBEY AND WALBRIDGE'S PAPER ON THE STANLEY ARC LIGHTING MACHINE.

itself. The plate contains but little detail. The carbons do not appear at all in the photograph, which shows little besides the periodic interruption of the arc. In later negatives the size of the image was greatly increased and the plate was driven much more rapidly through the field. In many instances two or more successive exposures were made upon the same negative. Inspection of Figs. 4, 5 and 6 shows that the greatest intensity resides neither in the arc itself nor on the incandescent carbons, but in a narrow region just at the ends of the arc. In this region, which, doubtless, is where the so-called "contact resistance" of the arc occurs, the illumination is sometimes intermittent as in Fig. 4; sometimes nearly uniform, as in Figs. 5 and 6. The relative width of the intervals of dark-field, produced by placing the arc nearly between the poles of a horse-shoe magnet, the lines of force being perpendicular to the axis of the lamp and parallel to that of the camera, the vibratory effect was much increased. [See Fig. 7 (*B*).] The bearded appearance of the arc Figs. 9, 10 and 11 is common to all the negatives taken while the arc was in the strong field. The spines are supposed to be the paths of very minute and highly incandescent particles expelled from the arc at a considerable velocity under the action of the magnetic forces. A continuous curent arc, also in a strong field, the conditions being as nearly as possible those under which Figs. 9, 10 and 11 were taken, gave a negative of which Fig. 12 is a very imperfect representation. The arc was flaming, and it will be seen that while the path of the arc itself is an unbroken, straight trace, the flames, which show themselves to the right and left hands, are irregularly intermittent. The negative shows, moreover, that the flame to the right hand, in the figure, is finely striated, reminding one of the image of a hissing, sensitive gas flame as the latter appears in the revolving mirror. This vibration, which must represent a pitch of several thousand vibrations per second, is in all probability the cause of the hissing of the arc.

In this brief discussion I have left untouched many points which will suggest themselves to those who study Mr. McMynn's photographs. The interpretation of many of the features of these plates is at present rather obscure, but it is hoped that experiments now in progress will add something to our present knowledge of the phenomena connected with the alternating electric arc.

* Tobey and Walbridge; TRANSACTIONS, Vol. 7, p. 367.
† Wiedemann: *Elektricität*, 4, p. 855.
‡ Joubert: *Journal de Physique*, Vol. 9, p. 300.

*It should be noted that Casselmann, as long ago as 1844, described the deflecting action of the earth's field upon the continuous current arc. (See *Poggendorff's Annalen*, 63, p. 585.)

The Perfection of Stationary Electric Motors.*

BY FRANCIS B. CROCKER.

INTRODUCTION.

A study of the history of the electric motor shows us that from the very beginning to the present time there has been a great tendency toward complicated, fanciful and unpractical designs, including outlandish forms of field magnets and unnecessary multiplicity of field cores and coils. In most cases, also, the mechanical construction has been very bad, the shaft being too small, the bearings being weakly supported, and the general finish and workmanship being rough and not up to the standard of first-class machinery. From the electrical standpoint the insulation has been very poor and shares equally with imperfect mechanical construction the responsibility for the numerous troubles and failures which have occurred with electric motors. The magnetic circuit of motors has also been designed in a way that indicates entire ignorance of the laws governing the production of a strong magnetic field. In all these respects the electric motor has been worse than the contemporaneous dynamo-electric machine, the reason being, I think, that the men who have studied and designed the dynamo have been more competent than those who have turned their attention to the electric motor, electric power being comparatively a more recent development of electricity than electric lighting. There have been, of course, notable exceptions to the general badness of motor design and construction, but in the case of all of these exceptions, which are few, I think, it will be found that the superiority of the motor in each particular case was directly due to the presence of an electrical engineer of recognized ability.

Electric motors are used for three different classes of work. First, transmission of power over considerable distances, for example, from Niagara Falls to Buffalo; second, distribution of power, for example, in a district of a city from a central station, and third, electric railway work.

The first of these classes of work usually requires large motors, over 50 or 100 h. p.; the second requires comparatively small motors, ranging between ½ and 10 h. p.; the third requires motors from 20 to 100 h. p., and a peculiar construction adapted to their special purpose. I purpose to consider in this paper motors of the second class for distribution of power especially.

It has long been my opinion that the proper way to design a good electric motor is to consider very carefully and systematically each part, first by itself, and then with reference to the other parts, and thus collect and build up the elements which are best, not only in themselves but also in combination with each other, so that finally, by putting and fitting these parts together with the best possible workmanship, the best result will certainly be obtained. The correctness of this procedure is so self-evident that it seems hardly necessary to uphold it, but every one familiar with electric designing of all kinds will admit that the usual process has been to invent some peculiar form of armature or field and then attempt to fit the rest of the machine to this particular part, producing all sorts of anomalous and awkward constructions. It will also be admitted that experience has taught us that the simpler and less extraordinary forms of machine have usually been more successful. In fact I believe there is no kind of electrical apparatus in which sensationalism in design has been successful, except perhaps in arc light dynamos. Let us now take up the various parts of the electric motor, and consider each as a simple problem in designing.

BASE.

This should be a solid iron casting, flat and simple in form, and resting directly and squarely upon the base frame or floor, which latter should preferably be of wood to secure insulation. The base should be heavy to bring the centre of gravity low; in fact, this is the only part of the machine where weight is not only not objectionable, but very beneficial, and since it is merely of plain cast iron the extra cost is insignificant. A heavy base does more than anything else to give great stability and strength to the whole machine, and is highly desirable in a stationary motor. The bearings should be directly and rigidly mounted upon this base, a simple fact that is often disregarded.

FIELD MAGNETS.

The field magnet should be *bipolar*, except in the larger machines, above 10 h. p., on account of the great complication caused by the increased number of armature sections, commutator bars, field coils, etc., necessary in multipolar machines, and the narrowness of the neutral or non-sparking space on their commutators; for example, multiple brushes or cross-connected armatures are particularly objectionable in small machines. The field should also be a single magnetic circuit rather than the consequent pole type, because the former is more economical in wire and current required. For example, one turn of wire around a 7-inch core is equivalent to the two turns of wire around two 5-inch cores, the cross section of one 7-inch core being nearly equal to that of two 5-inch cores, whereas the length of wire is only 70 per cent. as much with the single core. In other words, a single circuit requires only 70 per cent. of the weight of wire and 70 per cent. of the energy of magnetization that is required by a double magnetic circuit. A triple magnetic circuit or quadruple magnetic circuit—that is, three or four cores magnetically in multiple arc, are still more objectionable, requiring about twice as much wire as a single core of the same total cross-section.

The field magnet may be arranged with respect to the base described above in three general ways: First, the pole pieces may be set upon the base (Edison type); this form requires non-magnetic material, usually a zinc plate, to be interposed to prevent magnetic short-circuiting through the iron of the base. Even with a zinc plate Hopkinson found 10.3 per cent. magnetic leakage through the base of the Edison-Hopkinson dynamo.

Second, the iron base may form one of the pole pieces (Manchester type). This is also objectionable on account of the greatly increased magnetic leakage, which is practically proportional to the surface exposed to the air, and the extension of the base necessary for the bearings, etc., greatly increases this surface, and also allows the magnetism to leak up into the shaft, pulley, etc., causing various troubles. This form has the further objection that it is of the consequent pole type, the disadvantage of which I have just pointed out.

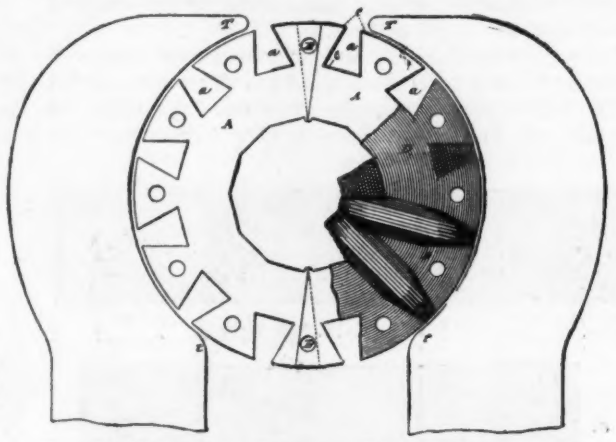


Fig. 1.—Method of Winding Toothed Armature.

Third, the iron base may form the yoke of the field magnet with the cores and pole pieces extending upward (Kapp or "inverted horseshoe" type). This plan has neither the leakage nor other faults of the other forms, and possesses the great advantage that the pole pieces are removed as far as possible from the base, bearings, etc, thereby avoiding magnetic leakage; and the base being purposely made heavy for stability and strength, as already stated, is therefore exactly suited to being used as the yoke, thus performing two functions to the best advantage. There is, moreover, no objection to using a cast-iron base as the yoke to complete the magnetic circuit, since the heavy base I have insisted upon is of large cross section and therefore of ample magnetic permeance, and the increased size of the iron yoke does not aggravate the magnetic leakage because it is magnetically neutral. The field cores should be of wrought iron because the field wire surrounds them, and the use of cast iron, which is of low permeability, would require a core of almost twice the cross section, and therefore a much greater length of wire to obtain the necessary magnetizing force. With the smaller wrought cores the magnetic leakage would also be less. The pole pieces should also be wrought iron to reduce their size and therefore their magnetic leakage, they being at the highest magnetic potential of any part of the machine. In regard to magnetic leakage, I would call attention to the fact that it is objectionable not only on account of wasting lines of force, but because it affects electrical instruments, watches, etc., in a very troublesome manner.

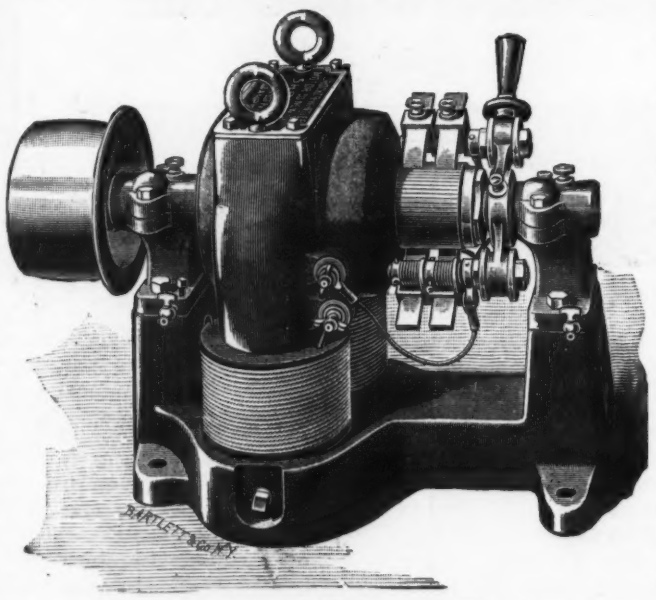


Fig. 2.—General View of the Crocker-Wheeler Motor.

The field magnet cores and pole pieces being preferably of wrought iron, the question of uniting them to the base and to each other next arises. Since any considerable fitting or working of wrought iron is difficult and costly, the best solution of this problem certainly seems to be to forge (i. e., drop forge) the core and pole piece in one piece. This also permits the bore or space for the armature to be perfectly formed at the same time. In connecting these cores to the cast-iron base it is practically essential to set them into it in order to get sufficient contact and strength, since the ordinary butt joint between wrought and cast iron limits the magnetic conductivity almost as much as if cast iron were used throughout. This method of putting the magnetic circuit together reduces the work of fitting wrought iron to a minimum, which work is the only objection to the use of wrought iron. The supposition that cast iron is cheaper than wrought for magnets is a fallacy, as its permeability is as much below that of wrought iron as is its price, both being about one-half.

FIELD COILS.

These should, of course, be perfectly insulated, a result which can be accomplished with certainty by winding them on a solid spool of material which is fire and water proof and highly insulating. These spools should never be made of material that softens by accidental heating of the wire, as this would allow the wire to cut through and make a "ground" on the core, which is just what the spool should prevent. I have tested spools of this kind which cut like cheese when a wire heated by a current was applied to them, this being a very effective method of testing this point.

ARMATURE.

In regard to the choice between the ring and drum forms of armature, the advantage of the drum is that it is easy to support mechanically, but it is difficult to wind, as the wire is apt to slip out of place and heap out on the ends of the drum, and more serious than anything else is the fact that the wires of a great difference of potential cross or approach very near each other, causing great liability to short circuit. The ring armature is somewhat hard to support mechanically, but the winding does not tend to slip out of place or pile out on the ends, and wires of the greatest difference of potential come at the greatest distance apart, that is, on opposite sides of the armature. This is of the utmost importance in the case of high voltage machines. In the case of large ring armatures or those with few turns of wire there is little trouble in winding; but in the case of the small ring armatures or where a great number of turns of wire are used, the ring should be split in halves to facilitate winding and put together afterward when wound.

TOOTHED ARMATURE.

The armature should have teeth or projections upon it in order to secure the following advantages:

First, to reduce the reluctance of the magnetic circuit and the weight of wire and energy of current required to magnetize it.

Second, to hold the wires in place and prevent them slipping tangentially on the core, the tendency to which is much greater than is usually supposed, there being a tangential pull of about 160 pounds on the wires of a 10 h. p. armature 8 inches in diameter running at 1,000 revolutions per minute.

Third, the teeth protect the wires from mechanical injury, since any blow or pressure which the armature receives comes upon them instead of upon the armature wire, which is very easily injured, and the machine thereby ruined.

TRAPEZOIDAL TOOTH ARMATURE.

A certain form of teeth I have found to possess decided advantages over the ordinary parallel sided teeth and slots heretofore used. This form of teeth is considerably wider at the top than at the bottom, which, of course, makes between the teeth a slot which is wider at the bottom than at the top. This shape of tooth and slot has the following additional advantages over those of the ordinary toothed armature—first, the wire is more completely held in place, being held against centrifugal force as well as against tangential force; second, the wire is also more perfectly protected mechanically, since it is almost entirely surrounded by iron; and third, the armature presents an almost unbroken magnetic surface to the pole pieces, thereby reducing to a minimum the reluctance of the air spaces in the magnetic circuit and the magnetic leakage, and avoiding Foucault currents and loss of energy in the pole pieces. This trapezoidal form of slots and teeth can be still further taken advantage of by giving the former a shape which exactly agrees with the form of a section of winding on the inside of the ring, as shown in Fig. 1, the interior spaces for winding being divided into the necessary number of sections by radial lines. This exact conformity between the inside and outside of the winding makes a perfectly symmetrical coil, with no tendency for a single turn of the wires to cross at any point, and the coils on the inside occupy the whole space with the greatest possible advantage, whereas ordinarily the interior of the ring is liable to be overcrowded with wires. The trapezoidal form of slot is particularly economical as regards winding, for the reason that there are a greater number of turns in the inner layers which are shorter and fewer turns in the outer layers which are longer, as shown in Fig. 1. The armature teeth make it easy to support the ring perfectly, since the bolts for carrying it may pass through the teeth without interfering with the winding. These bolts being held at the two ends by brass spiders or supports make a very strong and convenient means of mounting the ring upon the shaft, and thereby overcome the objection to the ring armature. In the trapezoidal form of teeth which I

* A paper read before the American Institute of Electrical Engineers, May 20, 1891.

have described there is even more space than in the ordinary form of teeth for the bolt-holes, and in this way larger bolts and stronger support can be obtained. The perfect insulation of the armature core is of the utmost importance. The best material and the most complete covering should be used, and the greatest possible care should be exercised to avoid short circuits, "grounds," or broken wires.

EFFICIENCY.

This should, of course, be as high as possible, and is made a maximum by reducing all elements of loss as far as possible. These losses are current to magnetize field, loss due to armature resistance, friction resistance of air, Foucault currents and hysteresis. It has always seemed to me that the efficiency is necessarily high if the machine is properly constructed, and if the efficiency is low it must be due to some loss, which is more objectionable in itself than because it involves a reduction in efficiency, because this loss must necessarily manifest itself in the form of heat in some part of the machine—for example, the field coils, armature or bearings. This heat is liable to do more harm by its direct effect upon the heated parts, causing a burn-out or charring of insulation in the winding or cutting of the bearings, and any effect of this kind is much more serious than the inefficiency from which it results. The same fact can be expressed in another way, by stating that if a machine can be run for one or two hours at full load without any part becoming overheated the efficiency of that machine must be high, unless the machine is very large and heavy for its power, in which case the surface for radiation and conduction would be great. This fact is more absolute than any efficiency test can possibly be, and very small losses which an efficiency test might not disclose would be indicated by local heating, if, for example, the effects are allowed to accumulate for a half hour of steady running.

THE MOTOR AS A WHOLE.

I can best illustrate the foregoing statements and recommendations by describing the set of electric motors designed by Dr. S. S. Wheeler and myself. They were developed by precisely the same process of reasoning as that given in this paper. Fig. 2 shows the general view of the motor; each of the parts and the putting together of the whole follows exactly the statements I have already made, and it is therefore only necessary to call attention to a few points.

The fields are put together according to a method illustrated in Fig. 4c, which consists in drop-forging the core and pole piece in one piece and exactly to shape; then mounting it upon a holder in such a way that the ends of the cores are trimmed with exact reference to the armature bore, and holes being bored in the cast-iron base the proper distance apart, the cores are set into it to the depth they are trimmed off and produce a space for the armature exactly suited to it. This is much simpler than fitting the field magnets and base together and then boring out the armature space, the operation of boring being a slow one and requiring heavy machinery. The field cores set into the base are shown in the skeleton drawing, Fig. 4.

The magnetic circuit produced by this method is excellent. In the first place, there are only two joints, and these are of very large surface and fit very perfectly, being where the cores fit into the base. The surface of contact of each of these joints is about four times the cross section of the core, and therefore about twice the cross section of the equivalent cast iron. The core and pole piece being made integral, avoids any joint between them, as well as any necessity for expensive work in fitting them together. In fact, the only machine work required in fitting the fields to the base is simply trimming off superficially the ends of the cores and reaming the two holes in the cast-iron base, these holes being cored out in the casting.

The armature is made with trapezoidal teeth, as shown in Fig. 1, and having an almost unbroken surface of large extent exposed to the pole piece, with a clearance of only one-sixteenth of an inch, the magnetic reluctance of the air gap is reduced to the lowest possible value. This exceedingly low reluctance of the magnetic circuit reduces the amount of wire required to excite the field to such an extent that only very short field coils and cores are needed, being only about one-third or one-quarter of the length required with armatures having no teeth and the ordinary air gaps in the magnetic circuit. This small quantity of wire on the field amounts to only twelve pounds in a three horse power machine and 16 pounds in a five horse power machine. It has not only the advantage in economy of wire, but also makes the machine very efficient as regards current consumed in the field, being less than two per cent. in the two machines referred to. The reduction of field wire and length of coil required is particularly important in

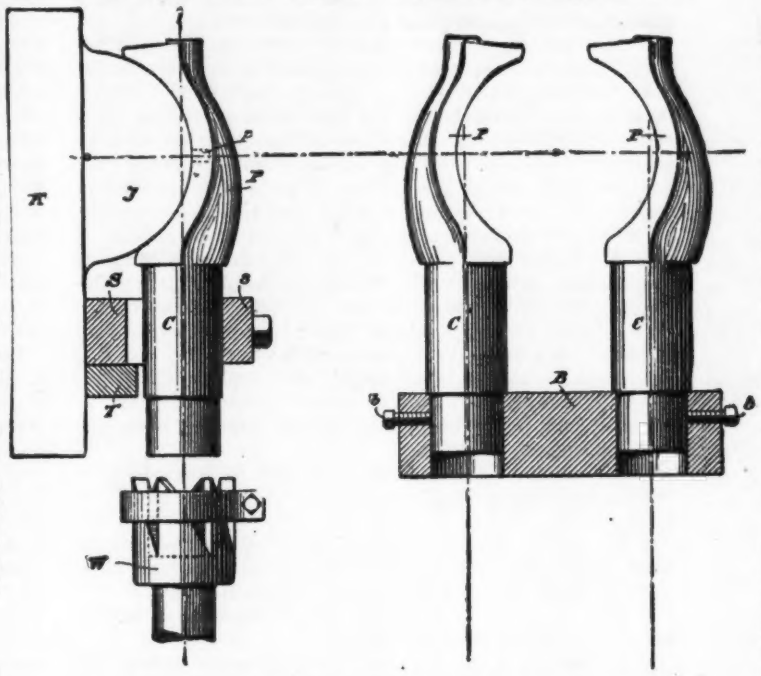


FIG. 4c.—METHOD OF FITTING THE FIELD MAGNETS.

bringing the shaft of the machine down sufficiently near the floor to give the machine stability and steadiness in running. In fact, the only objection to the "inverted horseshoe" type of field is that heretofore it has involved the use of long field coils, which brought the shaft almost twice as high above the base as it is desirable to have it, giving a top-heavy and unsteady result. In the type of motor described, the shaft centre is less than a foot from the floor in the three horse power size, and is just about the proper height to make the pulley, belt, gear wheels or other mechanical connections clear the floor and have sufficient room to work properly. This complete overcoming of the heretofore serious objection to the "inverted horseshoe" type makes a thoroughly satisfactory field construction without any of the disadvantages of all the other forms.

The actual results obtained from these motors, which, of course, is the most important and conclusive thing to know, are given in the following table, and include the various mechanical, electrical and magnetic constants of the machine. All the sizes of this type of motor are made almost exactly the same in design, proportions and construction, and differ only in scale; hence a description of one machine applies to all, with proper allowance for difference in size.

Data of three horse power Crocker-Wheeler motor, designed for 115-volt constant potential circuit:

Total weight	350	lbs.
Weight of field wire (No. 24 A. W. G.)	12	lbs.
Weight of armature wire (No. 13 A. W. G)	11	lbs.
Resistance of field	310	ohms.
Resistance of armature	.4	ohms.
E. M. F. of circuit	115	volts.
Total current at full load	24.3	amps.
Current used to excite field	.37	amp.
Percentage of current used in field	.015	
Total current required to run free	1.9	amps.
Percentage of total energy to run free	.08	
Commercial efficiency	.80	
Armature speed	975	r. p. m.
Total magnetic leakage or waste lines of force	.17	
Magnetic efficiency = Lines through armature / Total lines of force	.83	

The above data for the most part explain themselves, but I desire to call attention to several particularly interesting points.

The weight of field wire is extremely small, being only 12 pounds, compared with about 40 to 50 pounds in most machines of this size. I actually found the weight of field wire to be 60 pounds in a type of motor of equal capacity, which is claimed to have the best possible magnetic circuit.

The table also shows the current used in field to be only one and a half per cent., which is remarkably low for machines of this size, which usually require about five per cent.

The current required to run free, at full speed, is also exceptionally small, being only eight per cent.

The commercial efficiency is high for a motor of this size, particularly when the very low speed is considered, because an increased number of turns of wire on the armature is required to make up for the reduced speed, and this augments the armature resistance and causes loss. The efficiency does not vary more than about one per cent. from half to full load, which is quite an interesting fact.

The speed, it will be noticed, is very low for this size of machine.

The magnetic leakage or loss of lines of force is extraordinarily small, amounting to only 17 per cent., and giving what may be properly called a magnetic efficiency of 83 per cent.

This small magnetic leakage is due to the facts already stated in this paper in regard to the design of the field magnets. In this connection it should be remembered that Hopkinson in his classical investigations of the magnetic circuit found that there was 24.24 per cent. magnetic leakage in the Edison-Hopkinson machine. I may also state that Mr. A. S. Ives, student in electrical engineering at Columbia College, found 40 per cent. leakage in a well-known dynamo (400 light) of a recent though not the very latest type.

In conclusion, I would state that it is obviously impossible in one paper of reasonable length to completely treat the subject of motor design; but I have attempted to bring out the most important points, and lay before the institute the best results of considerable study and experimental

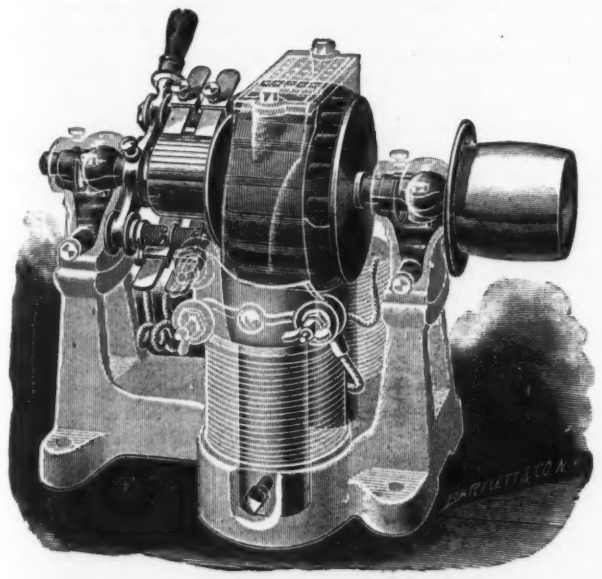
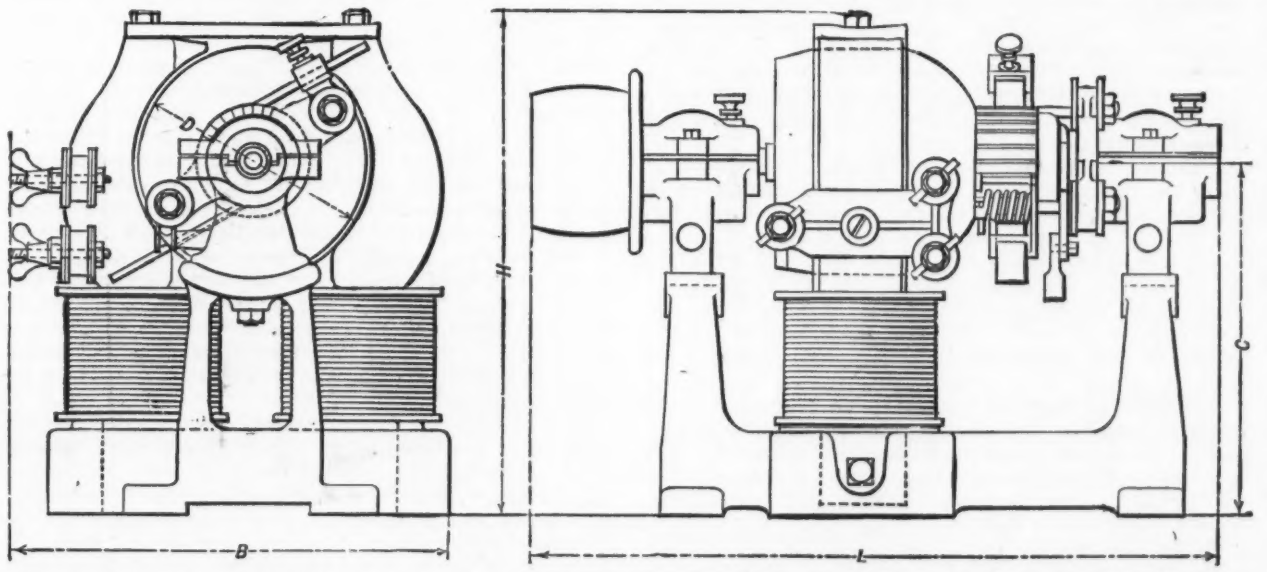


FIG. 4.—CROCKER-WHEELER MOTOR.



FIGS. 4a AND 4b.—DIAGRAM OF THE CONSTRUCTIONAL DETAILS OF THE CROCKER-WHEELER MOTOR.

TABLE OF DIMENSIONS, ETC., OF THE CROCKER-WHEELER MOTORS.

Horse power.	Net weight lbs.	Speed.	Pulley. "P." Diameter, ins.	Pulley. "F." Face, ins.	Size of Motor over all. "L." Length ins.	"B." Breadth ins.	"H." Height ins.	"G." Length between bolt holes in base.	"E." Breadth between bolt holes in base.	Diam. shaft, ins.	"D." Diam. armature ins.	"C." Height of shaft centre from base of motor.
¼	18	2,100	Grooved, 1⅛ or Flat, 1½	⅜ 1	7¾	6¼	7¼	4⅝	2¾	¼	3⅜	5⅛
⅓	26	2,000	Grooved, ⅛ or Flat, 1½	⅜ 1	9¾	7¼	8¼	6⅝	3⅜	⅝	3⅛	6¼
½	26	1,800	2½	1¼	9¾	7¼	8¼	6⅝	3⅜	⅝	3⅛	6¼
¼	65	1,500	3	2	14¾	9¼	10¾	9¾	4 1/16	⅞	4¾	7½
¼	100	1,350	3½	3	18¼	11	13	11⅛	5 1/16	1 1/16	5¾	9
1	157	1,050	4	3½	19	13¼	15¼	12¾	7	1⅛	7 1/16	10⅛
2	290	1,050	6	3	25	15⅝	18⅝	18¼	9¼	1	8¼	11 7/16
3	300	1,000	6	4	26¼	15⅝	18⅝	18¼	9¼	1	8¼	11 7/16
5	485	1,000	7½	4½	28	18¾	21	18¾	9¾	1⅜	9¼	12¾

work on the part of Dr. Wheeler and myself in the direction of improving and perfecting the design and construction of stationary electric motors.

There is one single merit in the paper to which I lay claim, and that is the fact that the ideas I have advanced are embodied in a large number of actual working machines, which are open to any one for examination and criticism, whereas the design of electric motors is usually given on paper only, and is therefore very intangible, and correspondingly safe, so far as the author is concerned.

Considerations Which Should Govern the Selection of a Rapid Transit System.*

BY FRANK J. SPRAGUE.

It has been but a short time since the Legislature of New York, in response to public demands as voiced by the press, in petitions, and through the personal efforts of the representatives of this city, enacted a rapid transit law to create a Board of Commissioners with large powers for the purpose of determining rapid transit routes for this city.

During the past three months the Commission appointed under this law has held numerous public meetings, at which various systems have been proposed. These meetings are now practically at an end, and it is currently reported that a portion at least of the rapid transit routes have been determined. Since this subject of transit is one which has a most important bearing upon present and future New York, and is one in which the public has vital interest, it is eminently proper that so much of the Commission's deliberations as have through its chairman been reported should be the subject of public comment and critical analysis.

The public is naturally impatient in demanding results, and has been unduly free in criticisms directed against the members of the Commission, often assigning to them motives and proposed actions based upon their known or assumed business associations, which criticisms are undoubtedly, in many instances at least, wholly unjust. On one subject, however, the public is particularly sensitive. It sees the daily encroachments made by the Manhattan system, apparently under cover of the law, but in direct violation of its express provisions, and has no reason to be other than suspicious of the acts and intents of that corporation.

Probably there is no more flagrant example of this than the present work being carried on from Fifty-ninth street up, on the Harlem division. Already the cross girders connecting the two track structures for nearly the entire section from Seventy-second street to above One Hundred and Fifty-fifth street have been replaced by heavy lattice girders, on which are supported either lattice or plate longitudinal girders for a third track. On a large portion of this section the third track has already been laid. The method adopted seems to be the construction of a switch connection of moderate length, the connection of which with the main track is eliminated as soon as another adjoining section is completed. The rapid transit law expressly forbids the laying of any third track except with the concurrence of every member of the Commission; and since it seems likely the Manhattan company would not go to the expense of making this change without some assurance that it would have the necessary permission granted to it, or that it would not be interfered with, the public naturally ask what is the influence possessed by this company? How far does it dominate the Rapid Transit Commission?

I will not undertake to answer these questions, but it should be remembered that this Commission is composed of five men whose selection at the time made met with general commendation; that they are each men of independent fortune; each is distinguished in certain independent business lines, and all are recognized as men of public spirit, capacity and probity. They are, moreover, armed with great authority, can be safely said to be conscious of the gravity of their decision, and intent on giving to it most serious and weighty consideration.

It is then fair to accord to them an honest desire to make a determination of this question of such character as will, both in the present and in the future, prove to be undeniably the best, reserving the right of criticism both of result and motives until after the announcement of a decision, which should not be unduly hurried.

Before considering the current reports of the Commission's deliberations, a general review of the subject may be advisable.

There are two classes of people who are concerned in the final decision made, the public and the capitalists. In order to satisfy as far as possible the demands of both, some of which are common, it is well to examine them separately.

To accommodate the public, it is necessary to:

1. Supply present demands by following as nearly as possible the most important existing arteries of travel. An express train on the banks of the Hudson would be of little use to Broadway.

2. Provide for those future lines of traffic which, other things being equal, will most naturally be formed.

3. Make the most numerous and convenient connections for existing and projected local and suburban transit lines in directions other than those followed by the main system.

4. Interfere least with changes in present buildings, or the erection of future ones. In no city in the world is this change more pronounced or continuous.

5. Cause the least disturbance to, or weakness of, foundations, present or future, and unnecessary displacement of service pipes, whether steam, gas, electric, air or sewer.

6. Avoid disfigurement of streets and unnecessary appropriation of them.

7. Inflict the least damage to property, either during construction or afterward in operation.

8. Provide the highest express and way speeds, each on independent tracks.

9. Attain this last with the least liability of derailment or other accident.

10. Provide the easiest access to stations; taking of all trains from one station; transfer from way to express trains and vice versa; from up to down trains, or to cross-town trains, or other intersecting lines.

11. Finally, it must be built as quickly as possible, and should possess great flexibility.

To attract capital the system—

1. Should afford a reasonable and certain return on the money invested in the near, and a greater return in the remote future.

To do this the road must attract passengers, which it will do by following the main arteries of travel, and by affording increased speed with increased comfort and safety.

2. Must be built economically and as cheaply as possible consistent with sound plans for future growth.

3. The cost should be calculable with reasonable accuracy. This cost is comprised in a number of elements as follows: (*a*) Preparation of way, such as tearing down buildings, digging up streets, moving pipe systems, altering sewers, sinking of shafts, etc.; (*b*) actual construction, such as building of viaducts, erecting superstructures, driving tunnels, laying road-beds; (*c*) temporary damage to and blocking of public and private business and travel during construction; (*d*) permanent damage to property, whether caused by proximity of road, noise, dirt or vibration, weakening of foundations, or interference with future buildings; (*e*) building space taken up, either by the roadway, moving trains, or necessary clearance above them; (*f*) equipment of rolling stock, less with steam, greater with electricity.

4. Should be such a construction as to make additional tracks possible, if future demands should warrant it, whether such tracks be parallel to, or intersect with, the main system.

5. The process of construction should be hampered as little as possible by injunctions or legal complications of any kind.

6. The place of construction should be such as can be most readily begun, most rapidly carried forward, and most quickly enable the road to become a dividend earner.

7. The franchise granted should be secure from unjust restriction and future interference.

8. The raising of capital should not be made difficult by the granting of privileges for extension to existing corporations of such character as to make their competition in the same field. An extension of the "Elevated" up the Boulevard would have an influence on any other system proposed for the same route.

That the demands of both public and capitalists as here outlined should be as far as possible met, goes without saying.

Up to very recently, from the reports of the proceedings of the public hearings which have been held, and the statements which have been made from time to time in the daily press, the Commission seems to have listened publicly and with patience to all plans of routes and construction submitted for its consideration, whether good, bad or indifferent; to have selected from these plans the limited number which during the past few years have more or less engaged public attention, and have at least the merit of financial backing, the record of operation elsewhere, or the promise in a more or less satisfactory degree of fulfilling the demands of a rapid transit system; to have examined privately some of the representatives of some of the leading systems; to have refrained from publicly discussed the question of motive power, but privately investigating it, and to have not yet determined what it shall be; to have expressed serious doubts as to the availability of electricity as a motive power; to have determined that unless electricity is used no form of tunnel, shallow, individual or deep, shall be used; to be making a personal investigation of the topography of the city with a view of determining its present needs and future lines of growth; to have determined to first lay out a west side route; to be attempting the coincident determination of motive power and route; and to be much concerned as to property damages.

Such, as I say, until very recently seems to have been the attitude of the Commission. About a week ago, however, when the public had received the impression that it had about reached a conclusion to at least a portion of its labors, application was made by the Manhattan company for extensions covering some eighteen miles of street. The character of the proposed construction, the routes demanded, are now matter of record.

It is but natural that the delays in submitting a route after the chairman of the Commission had announced that it was about ready to do so, being followed by an elaborate presentation by the Manhattan company of the plans for its proposed extension, which plans have taken a long time to prepare, preceded as this presentation was by an explicit declaration on the part of officers of this corporation that it contemplated no more extensions, naturally caused a feeling of distrust and uneasiness, and was followed by suggestions of possible bad faith on the part of the Commission; and this is no less annoying and disturbing because of its inherent improbability.

Why this action of the Manhattan company excites this feeling is easily explained. The portion of its scheme which most vitally concerns the city of New York is the proposed extension of the system from Thirty-third street up Broadway, through the Boulevard to 170th street, and its continuation. This is simply an iniquitous proposal—no other term can be applied to it—and if granted by the Commission, no matter with what restrictions, it will prove a vital blow to all real rapid transit in New York city in the life of this generation.

Let us see what would be the result of such an extension. That it would be built by the Manhattan company if granted the right is undoubtedly true; that it would prove a profitable enterprise is equally true; that it might be used for a repetition of the methods of financiering which characterized the consolidation of the elevated roads into the Manhattan system need not be doubted. That it will enhance the value of the property of that corporation needs no argument; but—

What will it do to satisfy the needs of those who to-day use the elevated railroads? How will it affect the well-being of this city? With what sacrifice of its best interests would these schemes be carried out?

It is hardly necessary to point out that neither public spirit, civic pride, nor any feeling, in fact, save the most sordid one, enters into the calculations of the Manhattan corporation. Its spirit is much the same as that which prevails, most unfortunately, in a large portion of our city government. It is: The public be damned! How much is there in it for us? Pass in your nickels; our water-works must be protected and extended.

It is well to recollect that some of the same men who have earned lasting condemnation of the public by their advocacy some time since of an elevated steel structure on Broadway below Thirty-third street have again come to the front in support of the Broadway extension above Thirty-third street.

The former scheme was for the time defeated. It has not been given up, but the basis of attack has been changed from lower to upper Broadway. Every capitalist knows the great value of a road of almost any character which can be allowed to follow this great artery of travel. Grant a franchise for the length of Broadway and the Boulevard, and there will be some interesting bidding for its control. The history of the Broadway surface road and the character of the street are in evidence. Hence the ultimate object of this corporation is a line for the whole of Broadway.

How does it propose to get it? Defeated for a time in its assault on the lower portion, it has for months been getting the consent of property owners along the upper Boulevard, who, seeing a prospective rise in the value of their property, and careless of, or indifferent to, the real welfare of the city, and ignorant of all systems save those presented by the Manhattan company, have in many cases agreed to make no claim for damages in case an elevated structure is put up. Armed with these consents and practically assured of the consent of a city government noted for its venality, anxious to add a heavily paying extension to its system, with lower Broadway as an objective point, and intent on defeating the raising of capital for any other system if reported, it now seeks the consent of the Rapid Transit Commission for this extension.

Consents thus sought and in many cases obtained ought not to weigh as an argument in favor of this extension, because the needs of these, the west side property owners and the Harlem goat, can be equally well served by another method of construction. That there is some explicit or tacit understanding with some of the city authorities seems evidenced by the continuance in its present disgraceful condition of the upper Boulevard, a street which was laid out for and can be made to be one of the finest in the world.

Let us suppose for a moment that the Commission so far prostituted its powers as to grant this extension, and it is built, what would be the result? It should be borne in mind that the traffic of the present Harlem division of the elevated road above Fifty-ninth street is mainly the growth of the past seven or eight years. It is a traffic created on account of the building which has taken place during that period. The Boulevard extension would not seriously divert travel from the present Harlem division. It would add nearly double that mileage to the present elevated system and would build up a traffic of its own. It is safe to say that in less than a single decade the travel on this extension would be greater than now exists on the Harlem division, while the travel on this latter would be in no wise lessened.

There would follow a congestion of traffic at and below Thirty-third street which cannot be realized, and this is precisely the result wanted by the Manhattan Company. It is impossible by any practical change in the Sixth avenue division to take care of this increased traffic, and the only outlet for it would be an extension of the road down Broadway.

Grant, then, the Boulevard extension for the Manhattan company, and within 12 months after the first train has run over that extension the necessary steps will be taken by this same corporation for the extension of the Boulevard line down Broadway from Thirty-third street, and they will get it. There is no avoiding this conclusion.

If present public opinion will permit an extension of this system above Thirty-third street on Broadway and the Boulevard for the benefit of the Manhattan company and the west side property owners, with the certain congestion of traffic on that section of the present road which vitally concerns all citizens, then it will in sheer desperation be compelled to acquiesce in the subsequent demand.

If to-day an intelligent and respected commission, made up of men presumably fairly representing the intelligence and public spirit of this community, cannot be relied upon to prevent the appropriation of one of the finest boulevards possessed by any city, forming the extension of one of the greatest business streets in the world, and the debauch of all real public interests by saddling upon this city the extension demanded, then it is hopeless to expect any future commission to withstand the pressure which would be put upon it.

If, then, it would save lower Broadway, it must protect upper Broadway. The system it adopts must be independent of, not dependent upon, the Manhattan system. The rights of the west side property owners must not be allowed to override those of the rest of the people in New York. Their interests can be better served by some other system which would give real rapid transit, and leave Broadway and the Boulevard uninjured; nor should the property owners of this section be themselves content with a higher speed above Fifty-ninth street, and a lower speed below Thirty third.

The question is not, how can the promoters of the Manhattan system find a most remunerative opportunity for the investment of additional capital, or how can they obtain the largest return with the lest expenditure? The public of New York is most concerned, possibly selfishly, with plans by which it can best serve its own interests, the real interests

* A paper read before the American Institute of Electrical Engineers, May 21, 1891.

of a great city, one fast outgrowing the iron-bound vision of the Manhattan corporation.

Fortunately it rests with any one man in this Commission to prevent any extension of the elevated system, and I think we can safely assume that no such extension will be granted except such as is consistent with the best interests of this city. I would not take the position for one moment that no rights should be granted to the elevated railway other than they now possess. I would say, let its service be improved as much as is possible, but such improvement of service should not be coupled with extensions which stand as barriers to a proper solution of this problem.

If there were no other way, nor any better one, to obtain rapid transit in this city than by the system set forth by the Manhattan company, I should say by all means let the system be thus extended; but every one within reach of my voice knows that other methods of construction can be adopted which are free from a large number of the objections which are inherent in the elevated railway system, and knowing this, we are justified in doing what lies in our power to aid in the adoption of such other methods.

In investigating the various systems it is pertinent to inquire: When was each proposed? How comprehensive is its character? Which presents the most modern and progressive engineering? Which will best satisfy the future as well as the present needs of New York City? Which will cost least, be most quickly constructed, and hence most strongly appeal to capital?

To satisfactorily answer these queries there are three things to be determined. They are: Motive power, method of construction, and routes.

In order that the Commission may have the greatest latitude of judgment, these should be determined in the order named; that is, the determination of motive power should precede that of construction, and the method of construction that of route.

Two systems of motive power only are under consideration, steam and electricity, the former a well-known agent whose advantages and disadvantages are well known; the latter a newer application of force, one in which the layman is not so well versed, but one whose advantages and possibilities are well understood, and most thoroughly relied upon, by those who have made it a particular study.

The vital importance of letting the determination of motive power precede that of construction and route will be clearly illustrated by noting the limitations upon construction. There are five general plans which have been proposed:

A. An elevated steel structure, similar in character to the Manhattan system, and occupying the public streets.

B. The viaduct masonry construction similar to some of the London sections of English trunk line systems, the viaduct road of Berlin, or the Broad street section of the Pennsylvania Railroad in Philadelphia, to run through the middle of building blocks, and to span the streets with steel arches.

C. A shallow tunnel made by excavating the streets, removing or diverting the existing system of pipe services of all kinds, running the tracks in one or two tiers, either superposed or in different vertical planes, the street to be floored over with a steel girder structure. The inclosed track would be something like the Fourth Avenue Harlem Road tunnel, except that it would be entirely inclosed.

D. An iron tubular closed tunnel construction, the tubes running at a depth of from 20 to 40 feet below the surface, and built something like the North River tunnel, but individualized like the Suburban & South London Road, constructed in London by the Greathead interests and opened for regular service last November.

In this system the various tracks would be generally independent, and the way and express routes likewise independent save at common intersecting stations.

E. A deep rock two-track tunnel, identical in character with every other rock or mining tunnel with which we are all familiar.

If electricity be adopted as a motive power the Commission will be left untrammeled to determine which of these constructions is preferable. If steam is adopted, considerations of construction are at once limited to plans *A* and *B*, and even then there exists a limitation in the viaduct system not yet realized, to which I will soon refer.

I think it may be taken for granted, first, that a west side route should come as near Broadway as possible; second, that a four-track system is essential, because higher speed and greater capacity are required, and both way and express service must be provided.

An elevated structure necessitates the appropriation of streets already needed for other purposes. If for four tracks in one plane such a system is impossible in most of our streets. It is hardly necessary to further discuss the objection to this system.

A viaduct construction requires for every foot of way, except at street crossings, the condemnation and purchase of property of great value in the business heart of the city, of an aggregate far exceeding the proper cost of road construction. It means the tearing down and re-erection of many buildings, the interruption and cessation of the business carried on, with all the necessary legal complications which will surely follow, thus increasing the cost of construction in an unknown but material way, and it would require extra provision of capital for the purchase and alteration of these buildings.

But, as I have intimated, there is a distinct limitation to this plan in the simple one of motive power. There are two plans of constructing such a viaduct, one by making a clean cut through the buildings, leaving the roadway uncovered, and the other by tunneling through the buildings. If the former plan is adopted there would be thrown away a continuous strip of block space in the most valuable section of the city, from 25 to 50 feet in width, according to whether the tracks are in one or two planes, and from 50 to 300 feet in height. Although the value of this wasted space is well nigh incalculable, it is the only plan by which steam could be made available, because if the roadway is covered in the block spaces and steam be used, the same objectionable features would exist which have given the Fourth avenue Harlem tunnel so unenviable a reputation, and the damage to property would be even more pronounced. If, however, the viaduct construction were adopted economy would demand the tunneling rather than the cutting down method of getting through buildings. This consideration would then require the abandonment of steam and the adoption of electricity.

But suppose this suggested construction and motive power be adopted in the populous portion of the city, and the street crossings be left open; there would then be that most disagreeable alternation of light and darkness, or of a greater or less degree of light, which is another of the objectionable features of the Fourth avenue tunnel, and hence the crossings themselves must be inclosed, and with what result? The additional disfigurement of the street may be ignored, but there would be simply an elevated tunnel of the most costly character, supported on a masonry viaduct, and a system of most questionable financial promise.

In considering an elevated or viaduct structure following the approximate route outlined it is well to note what obstructions would be met in its course in the lower part of the city.

How, for instance, would such a system cross the Manhattan system at Thirty-fourth, Fifty-third and Sixty-fifth streets? Would a grade crossing be advisable or permissible? Unquestionably not, for the danger of collision and the delays and blocks would at once condemn it. If not a grade crossing, then which road would be uppermost? The Manhattan being already in possession, the new system must do the crossing, and at abnormal elevation. What would be the effect of the operation of such a road upon the Metropolitan Opera House?

As regards stations, the elevated and viaduct plans require separate up and down platforms, and it would be interesting to inquire how with the limitations which must exist on roads of this character it is possible to serve way and express tracks on a common level except by making them common at the way and express stations. The danger attending this practice must be apparent.

Returning again to the question of motive power, it is important to know what are the objections raised against the use of electricity. About the only one made public is that it has not yet been used on as large a scale as would be required in the proposed system. This reason seems ultra-conservatism, and it is to be regretted that on a subject of such vital importance there has not been a more thorough public inquiry made.

This same view was taken of the application of electricity to street railway propulsion only three years ago. There was scarcely an engineer, a street car builder, a street railway constructor, or a capitalist who did not laugh at the claims which were made for it; and yet in this short time there has been a total revolution of feeling. There is not probably a street railway manager in the United States who does not thoroughly believe that electricity is the present and coming power for street railways, and who, if he were constructing a new road or re-equipping an old one, would not at once, or in the near future, adopt electricity if he could get the necessary rights to do so; and it should be borne in mind that the equipping of these roads has meant in very many cases the entire rebuilding of the track, the purchase of new cars, the building of costly stations, and, in short, the investment of a greater capital than had already been invested in the original plant, so that $50,000,000 is a small estimate of the sum which stands invested to-day in this one industry alone.

If, however, the Commission is still in doubt, then, in order to get a more intimate knowledge of what electricity can do as a motive power, it would seem proper, First, that a time be set apart for the public examination of electrical engineers and contractors; second, to require a private statement from electrical engineers, confidential if desired, as to any new developments not publicly known; third, to visit two or three of the prominent electrical establishments to see what has been, is being, and what will be, done in general electrical machine construction; fourth, to then state what duty would be demanded of electric motors, and what guarantees of performance would be required under forfeiture.

If something like this be not done, then I think it safe to say that the rejection of electric motive power will be because of the following reasons: Its novelty; allowing accidents incident to the early period of its development to outweigh in importance its demonstrated advantages; a conclusion that it is limited in capacity and development; and lack of information as to its past, present and promised future.

Such a rejection would be upon technical advice relied upon by the Commission. This, it would seem, ought to be that of the Board of Engineers, not the judgment of any one man, because no one has sufficient experience to warrant such reliance upon his dictum in a matter of so grave import, and on a subject to which so many able engineers are devoting themselves, and the development of which has enlisted so many millions of capital.

The motor equipment on, for example, the present London road is composed of 100 h. p. units. That required on elevated railroads is 125 h. p. Attach four motors of the London type to the same circuit instead of two, govern them, as is perfectly feasible, by the same controlling device, and they will out work any elevated road engine. Increase the dimensions in these machines one-third only, and two of them will do the work of this engine. Duality may be objected to, but it should be borne in mind that duality of engines is absolutely necessary in a locomotive for successful operation. It is not essential in an electric motor equipment, although advisable for traction purposes. But for that matter double the dimensions of a London machine and it alone will outwork the two cylinders of the elevated locomotive.

Perhaps one of the most telling arguments in favor of electrical propulsion is the fact that in London another underground road to be operated by electricity is about to be constructed on plans already approved by a Parliamentary committee. This road is about six miles long and connects the West End with the city. It forms approximately a diameter of the oval described by the present steam underground railways. A 5,000 h. p. station at the suburban end of the line will supply the current. The trains are to consist of six cars seating about 340 persons and will weigh with the electric locomotives 120 tons. The average speed is to be 14 miles an hour including all stops, with a maximum of about 25 miles an hour. Since this weight, power and seating capacity exceed that now common on the elevated railroads, it is a somewhat practical answer to the objections made on this point.

There have been no demands for a 2,000 h. p. steam locomotive, but there is not a builder in this country who, given suitable gauge of track and allowed dimensions of engine, would hesitate a moment to build a locomotive of that capacity.

So, too, with electric motors. Given the incentive, and before the first foot of roadway is ready on the proposed rapid transit system of New York, a 200 h. p. electric locomotive will be built which will, under forfeiture, outwork any elevated road engine for speed, pulling capacity, steadiness of work, time of operation and continuous mileage. This statement is made from personal knowledge, and with an individual willingness to assume the risk.

Break a single part of the many in a locomotive, and it is helpless. Break many of certain parts in an electric motor, and it will, although crippled, still operate. In short, the near future will make the electric motor the most reliable machine constructed for power purposes.

What is the experience of other large cities in this matter of rapid transit? In London the same interest which built the Greathead tunnel has been granted Parliamentary rights for extensions, ordinarily most bitterly fought against, with an almost unexampled unanimity. Paris is considering seriously the question of a great metropolitan underground electric system. Boston has been advised, after most careful investigation, that the only proper system for the business portion of the city is an underground electric system.

As regards New York, while unnecessary delay is to be avoided, it is certain that no present delay is half so serious in its consequences as the adoption of an inferior plan by reason of immature consideration, lack of knowledge or information, or in response to popular clamor. The demands of to-day can be best served by plans to meet the future wants of New York as well, while the needs of the future cannot be properly provided for by planning for present limitations.

In discussing the subject some time since in a communication addressed to the Commission which contained the gist of much I have already said in this paper, I made the following suggestions:

It is possible that the Commission, while still in doubt about the availability of electricity as a motive power, may feel it incumbent upon them to announce some decision with regard to at least one route. Would it not then be possible to submit two alternative propositions, the preferable one of which could be determined by public comment and criticism and the readiness with which a responsible construction company would bid for the necessary right and franchise?

First. Questioning the availability of electricity, select the best system which can be devised other than an underground system, that is some elevated or viaduct structure. Specify the number of tracks, the route over which it shall run and make steam the motive power.

Second. Accepting the statements which are made in favor of electricity, select the best underground, or combined underground and viaduct and surface system, which will answer as far as possible the demands which have been enumerated. Establish the route, the number of tracks, and make the use of electrical obligatory.

Third. Demand as regards (*a*) construction: Earliest time of beginning; greatest freedom from interference, either with streets or existing systems of pipes; least damage to property, most rapid progress of work and earliest construction.

(*b*) Results: Mean and maximum speeds, number and weight of trains operated, approximate cost of motive power per train mile under these conditions.

(*c*) Guarantees under forfeitures: Against construction damages to buildings or foundations, against future damage claims.

Then let the public discuss the merits of these alternative propositions, and let a construction company or companies bid on these systems and on the franchise accompanying such bid with a proffer of a certified check of sufficiently large amount, and then see which company will: (*a*) Guarantee to build most quickly, (*b*) Make the best offer for the franchise, (*c*) Offer the highest guarantees, both as to progress, cost and satisfactory operation.

As I close this paper there comes news of most reassuring character, for the chairman of the Commission is reported in Tuesday's *Commercial Advertiser* and in Wednesday's morning papers as stating in the most emphatic manner that the Commission is planning for future New York, and that it will under no consideration even consider the plans of the elevated railroad until after it has determined upon a route to satisfy the demands of that future.

This statement of the chairman is most opportune, and will go far to allay the anxiety which has been honestly felt by those who await the result of the Commission's deliberation.

It is also stated, presumably on the same authority, that a system and west side route from the Battery to the Harlem River has been definitely settled, part underground and part viaduct, and the announcement of this decision will be definitely made next Tuesday. If so, then it would seem that electricity has now the victory, and the particular method of construction and the route selected will form the subject of discussion.

Electric Meters.*

BY GEO. W. WALKER.

The time has come for the central station companies to realize that they must supply the electric current in a more thoroughly commercial manner, that is, it must be sold as other commodities are sold, by measure, weight or its equivalent. To convince, however, an already skeptical public that the electric current can be measured with as great, if not greater, degree of accuracy than the established and accepted methods of measuring gas, water and steam, is no small undertaking. The fact remains, however, that we have to-day a number of electric meters which will measure the electric current more accurately and thoroughly than instruments adopted for similar purposes in other branches of business.

We have, it is true, one great question which we cannot answer, and that is, what the electric current really is. We explain this, however, by saying we can measure its effects, which are reflected either in light, heat or power. Fortunately for us we have adopted units which are universal; the couloumb, ampère and ohm represent values practically the same throughout the entire world. Therefore we start out with fixed rules which must be recognized as well by the old world as the new. Compare this fact with the different weights and measures adop ed by various nations and countries, and see what universal dissimilarity exists. Imagine for a moment what consternation would exist in the great dry goods business if it were possible to instantly transfer all our yard sticks to France and their meter sticks to this country – the result would be to momentarily paralyze their business. We can, however, place our measuring instruments on any circuit, and the result remains the same, and is read with the same degree of certainty and accuracy by all nations.

As gas was the follower of the tallow dip, so is electricity the successor of gas, and one of the legacies inherited by us is the much abused and anathematized gas meter. The peculiarities of this somewhat venerable object are numerous, sometimes amusing, many times annoying and expensive, as our personal experience will prove. The original gas meter was a very crude affair indeed and would insist on freezing or drying up at the wrong time. Probably many of us could tell amusing experiences which have befallen us in our endeavor to make it work. Its progress to its present state of perfection was very slow. In fact, for almost, if not quite, 20 years after it was first introduced no improvements were made upon it. Much as we blame and question its arithmetic, it is undoubtedly a very reliable instrument. It has, however, by comparison, caused the ever-suspecting public to look with suspicion upon the electric meter, even though they see the wheels go around.

In presenting this subject to you, it may be interesting to know that although there are but a very limited variety of electric meters now on the market, this number does not in any sense represent the thought and time that have been given to this particular branch of the electric field. A perusal of the United States Patent Office reports shows that up to date about 185 patents have been granted on electric meters alone. The first patent granted by our government on electric meters was No. 132,569, dated Oct. 29, 1872, and issued to S. Gardiner, Jr., of New York city. The principle of this meter consists of an electromagnet, having its armature connected to a releasing device of a clock movement, the dials of the movement indicating the time during which an electrical current is in action.

No further patents were issued until the year 1878, during which year a patent was granted to W. E. Sawyer, also of New York city. The same month, Nov. 26, a patent was issued to J. Billings Fuller, of Brooklyn, N. Y., on what was perhaps the first alternating meter invented. His invention is embodied in one claim, which reads as follows: "An electric lighting system in which the light is produced by alternating currents, an electromagnet placed in the main or induced current circuit, or in a shunt therewith connected and having a polarized armature, the vibrations of which actuate a train of registering wheels, substantially as and for the purpose specified."

The patents granted to Sawyer and Fuller were the only ones issued in 1878. One patent was granted in 1879; three in 1880, seven in 1881, seven in 1882, eight in 1883, nine in 1884, five in 1885, 12 in 1886, 13 in 1887, 22 in 1888, 36 in 1889, and about 60 during the year 1890 and up to the present time. You see, therefore, that considerable time, brains and money have been expended in the direction of perfecting the electric meter. A careful examination of the 185 patents issued reveals many ingenious devices for the measurement of the electric current; but in most cases the expense of manufacture, the liability to derangement and the cost of operation kept these meters out of the race, from a practical standpoint. It would be impossible in the time allowed for this paper to describe a great many meters. I presume you will be interested only in those which have been placed prominently and in a commercial manner before the American public. I will take them up according to their seniority and describe them as briefly as possible.

The first to be considered is the Edison electrolytic meter. The fundamental patent taken out by Mr. Edison on his chemical meter is No. 251,545, dated Dec. 27, 1881. In the patent an electromagnet is claimed as part of the meter, the principal claim, however, being the use of an electrolytic cell placed in a shunt circuit, the resistance being so proportioned that a definite fraction of the current passes through the cell. The chemical action of this meter when in use consists in depositing metal from one electrode to another, the rate of deposit being regulated by the amount of current passing through the meter. The electrical energy consumed is measured by ascertaining the increase of weight of the electrode which receives the deposit. Subsequent to the issue of this patent Mr Edison devised various modifications of this meter, introducing recording devices as in patent No. 304,082, which provides for the use of two electrolytic cells, one plate of each being suspended from the beam of a sensitive balance, the circuit being so arranged that one cell is in circuit at a time; the direction of current in that cell is such that the electrolytic action in it will throw the balance out of equilibrium, causing the beam to kick, and by that action throw the current to the other cell and register one on the counter. Various other devices were patented and experimented upon by Mr. Edison to accomplish similar results. He also devised a meter upon the motor principle, a patent for which was allowed him June 14, 1881, No. 242,901. However, he finally adopted the electrolytic cell meter pure and simple as the one to offer to the public in a commercial sense.

The meter as used to-day by the Edison company is but a slight modification of the original plan. Mr. A. E. Kennelly, in a paper which was read before the Association of Edison Illuminating Companies, at Minneapolis, is my authority for stating that the bottles, plates and resistance in the present three-wire Edison meter are of a uniform size without regard to the size of the meter. For example, it is so arranged in the smallest meter that each milligramme of weight transferred represents one ampère hour of supply, the rate of transfer being ten milligrammes per hour at a full load. In a No. 8 meter each milligramme of deposit would represent eight ampère hours, a No. 4 meter four ampère hours, etc., the meter number being the index of the supply in each case. It is claimed that making all bottles, plates and resistances uniform in size has simplified in some degree the handling of this meter. While this may be the case, we must not lose sight of the fact that another constant has been introduced which is governed by the size of the meter. This, together with the fact that only $\frac{1}{875}$ part of the current supply passes through the meter, allows a possibility of quite a large error. I will not weary you with a dissertation on bottle resistance, oxidation, the correctness of the German silver shunt, etc., etc. I will merely add that although the Edison electrolytic meter has been criticised very severely by many prominent electricians, and much has been said pro and con. about it, we must all acknowledge that it has been introduced quite extensively by the Edison company, and has, in a commercial sense at least, proved a success.

The Shallenberger meter is of the motor type and is devised for the alternating current only. The first patent allowed to Mr. Shallenberger was No. 388,003, and dated Aug. 14, 1888.

The elements employed in the construction of this meter are, first, an armature of metal capable of rotation; second, an electric circuit which is so arranged that when it is traversed by alternating electric currents a field of force is induced having a given polar line or axis with reference to the armature; and, third, a circuit so regulated to the first circuit that currents are produced in such second circuit by the action of those in the first, the phases of which succeed those of the currents in the first circuit and set up for the armature a second field of force, the axis of which intersects that of the first. To the armature is attached a shaft, which, by a worm gear, operates a suitable dial train representing the number of revolutions made by the armature. Means have been provided to retard the speed of the armature by introducing a set of fans or vanes, which are also attached to the shaft. It is claimed by the inventor that the retarding effect produced by the fans or vanes should increase as the square of the speed, inasmuch as the tendency of rotation increases as the square of the current; whether this has proven to be a fact, those who have used this meter can best decide. Like all other motor meters the difficult points to solve are the production of the proper speed on very light load, and to have the retarding action correct as the load increases. Mr. Shallenberger has recently taken out a number of patents consisting of improvements and modifications of his original claims. One of his recent devices provides for cutting the meter out of circuit when all the lamps have been turned off; it has been found that even though all lamps are out, there is still a leakage occasioned by the transformer, and the inventor concludes it to be unwise to ask the consumer to pay for such leakage.

The patents of Mr. Shallenberger are now owned and controlled by the Westinghouse Electric and Manufacturing Company, and this meter has been introduced by that company quite extensively both in this country and abroad.

Next we will consider the Aron meter, invented by Mr. Aron, of Berlin, Prussia. This meter has as its underlying principle the ascertaining of current consumed by noting the difference in the rate of movement of two clocks, one of which is affected by the passing of the electric current. The apparatus consists substantially of two pendulums regulated so as to have synchronous oscillations. The left hand pendulum is of usual construction; the right hand pendulum carries at its extremity, as weight, a steel magnet. Each pendulum is kept swinging by a clock movement actuated by spring power. Both pendulums act jointly upon one dial train, which counts the difference of their oscillations. As long as no current passes through the counter coil fixed below the magnetic pendulum, both pendulums oscillate synchronously and the dial train is at rest; as soon, however, as the current passes through the large coil, the time of oscillation of the magnetic pendulum is affected, so that it swings faster as the current passing through the coil increases, the dial train registering the oscillation of the magnetic pendulum. In order to take a reading of the current consumed, it is necessary to multiply the degrees marked on the dial by the constant, which is determined for each meter individually. The clocks are supposed to run thirty days with one winding.

This meter has been introduced quite extensively in Berlin. Judging from its general construction it should give very accurate results if operated under favorable conditions. Its size and cost, however, have prevented any general adoption of it in this country. I understand their representative in America has concluded to give up the fight and return to Berlin. This, I understand, was hastened somewhat by the passage of the McKinley bill, which imposed such heavy duties on their importation as to make it impossible to compete successfully with the other meters in the market.

Prof. Elihu Thomson has probably been the most prolific inventor of electric meters, as the Patent Office reports will prove. Previous to bringing out his wattmeter, Prof. Thomson's efforts were largely directed to perfecting what might be termed vapor meters. The general principle of this character of meter is the evaporation by heating effect of fluids such as alcohol, ether and water, such fluids being confined in sealed vessels or chambers. Each meter provides for the use of two or more glass chambers, such chambers being connected by a suitable glass tube and then delicately poised. By the heating effect of the passing electric current a change in the weight of one or the other of the vessels is produced, which disturbs their equilibrium, and by a suitable arrangement counts their oscillations upon a dial train. Prof. Thomson has devised many interesting devices operating on this principle, but unfortunately they did not appeal to the commercial public in a favorable manner.

His most recent invention, and the one which has been adopted by the Thomson-Houston Electric Company, is what is known as the Thomson wattmeter. This meter is of the motor type and consists of a set of coils wound on a hollow frame, forming what might be termed a Siemens armature of polygonal outline, without any iron core. Passing through this armature is a vertical shaft which rests in jeweled bearings at the top and bottom. The coils of the armature are connected to a commutator carried on the shaft near its upper bearing. Two light springs bear upon this commutator and constitute the brushes. The coils of the armature are wound with fine wire and have in circuit with the same a resistance which is wound according to the voltage required. The armature and resistance are usually connected in shunt across the mains. The armature has surrounding it a set of fixed coils, forming the field magnets, through which the current to be measured passes. Attached to the shaft which passes through the armature is a gear which engages with a train of dials or counters for the purpose of recording the revolutions of the armature and consequently the amount of current consumed. The means provided to regulate the speed of the armature consists of a copper disc which is also attached to the armature shaft. This disc rotates between the poles of a number of permanent magnets, and is retarded by their influence. In this case, as in other meters of this type, the difficulty of securing proper speed for light load and regulation on heavy load, is the great question to overcome.

The claim that this is an absolute wattmeter I fail to see the justice of, inasmuch as the armature and resistance must be specially wound for any given voltage. For example, a meter wound for the 110-volt circuit will not operate correctly on a 60 or 75-volt circuit, and vice versa. In fact, it is absolutely necessary to correctly wind the armature and resistance for the given voltage of the circuit upon which the meter is to be used.

The tendency of this meter to continue to operate after all lamps have been turned off has, it is claimed, been in a measure overcome by the use of brass instead of iron in the frame of the meter. However, the permanent magnets surrounding the copper disc seem to give out lines of force creating a field for the armature, which is usually in shunt across the mains, and in case the armature and resistance are not adapted to the voltage of the circuit, the meter will continue to operate for or against the consumer.

The principle embodied in this meter is not new, and it is only fair to add that as far back as the years 1883 and 1884 patents Nos. 233,547 and 304,881 were taken out by Mr. Edward Weston on a meter of similar construction. The claims of Mr. Weston's patent provide for the use of a motor in which the armature is connected across the mains, and a suitable device for regulating the speed, also a dial train to record the number of revolutions made by the armature representing the amount of current consumed. Mr. Weston's method of controlling the speed of the armature provides for the moving of one of the field magnets to and from the armature; otherwise the principles embodied in these two meters seem very similar.

The meters which have thus far been described all provide for measuring the amount of current consumed in a cumulative manner, either by a series of dials or by ascertaining the amount of metal deposited on an electrode. Therefore any question as to the correctness of the result attained cannot be explained in detail. As I stated before, the gas meter is our legacy, and, strange to say, the efforts thus far made by inventors have been to produce a meter resembling the gas meter as much as possible both in its appearance and operation. The meter which I will next describe is one with which I am the most familiar, and which differs in its operation from any thus far brought to your attention. This is the Walker meter.

It has been usual, in testing any electric meter, to place in the circuit with it an ammeter for the purpose of proving the correctness of the meter's operation. Assuming this hypothesis to be correct, we have in the Walker meter the element of a test instrument, inasmuch as the meter consists principally of an ammeter, which measures all the current passing, and records, by photography, the various positions occupied by the ammeter needle. The use of photography in this case is to eliminate the element of friction in the meter. When I use the word photography, I do not wish to imply that there are lenses or any of the necessary devices pertaining to the photographic art to contend with. The apparatus is simply so arranged that the ammeter needle point is represented by a speck of light, and as the needle moves its position, this point of light traces an image on the sensitive paper which is immediately behind. In other words, we are practically photographing the position of the ammeter needle during such time as it is being affected by the passing current, and the result is a continuous line marked upon the sensitized paper, representing the fluctuations of the ammeter needle.

In detail, the meter consists of an ammeter coil or solenoid, in which an iron wire in the shape of a nearly complete circle is placed as a core. The same shaft to which the circle or core of the ammeter is attached has also fixed thereto a light aluminium sector provided with a narrow vertical slot, this

* A paper read before the American Institute of Electrical Engineers, May 21, 1891.

slot representing the needle or pointer of the ammeter. Immediately behind this sector is a box which incloses a roll of sensitized photographic paper. The screen placed between the sector and the box has a horizontal slot before which the sensitized roll is made to pass.

The vertical slot in the sector is so arranged as to come at right angles with the slot in the screen, so that in whatever position it may be it will always allow a point of light to pass from the lamp which is inclosed in the meter on to the roll of sensitized paper.

Perforations in the screen representing the calibration of the instrument cause continuous horizontal lines to be printed on the sensitized paper. Another horizontal slot below these perforations is covered by a shutter which is opened every hour by the clock movement and causes vertical lines to be printed across the sensitized paper, representing hours of service. The number of the meter is also printed every hour just above this hour line. Means have been provided for causing a continuous movement of the paper roll at a given speed, and this is effected by the use of a small clock movement which is wound automatically by the electromagnet placed in shunt circuit with the lamp in the meter. The clock movement remains stationary and the lamp goes out when no current is on the circuit, but both start up immediately upon the lighting of a single lamp. In this way there is impressed upon the moving paper roll a complete record in a detailed manner of the current consumed in the circuit for a given time.

The roll of paper after a certain time, say one month, is taken from the box and developed in the usual manner, so as to fix the light impressions. It can then be measured up in the same way as an indicator card, by the use of the planimeter. The consumer is therefore at any time able to check the charges made, and the records being permanent can be used for future reference. It is evident that a large number of rolls can be developed in the same time required to handle a single one; in fact, the number is restricted only by the size of the vessel used. In the meter as at present manufactured, each square inch on the diagram represents 16 ampère hours, therefore the total number of square inches measured by the planimeter need only be multiplied by 16 to arrive at the sum total of the energy consumed. The loss in operating this meter is confined to the energy required to burn one lamp in the meter which at the candle power used takes one-sixteenth of an ampère. This is the maximum loss whether the current of one or 1,000 lamps is being measured, the ratio of loss decreasing as the load increases.

The only care required in operating this meter is in placing the sensitized paper in the holder. In order to do this satisfactorily, a dark room should be built in a convenient portion of the station. A window of dark yellow glass in this room will provide plenty of light to the operator, but if more light is required this window can be covered with yellow post-office paper and an incandescent lamp suspended before it. The sensitized paper in rolls of sufficient length for one month's use comes in sealed packages, and must only be opened and placed in the holder in the dark room. A boy can be instructed to collect the boxes, as skill is not required. As stated before, the meter number is printed on the diagram every hour, therefore it is not necessary to keep any record of the box itself.

It is evident that a meter which provides means to compute the current consumed in a detailed manner has advantages which other meters do not possess, inasmuch as any question as to the correctness of bills rendered can be satisfactorily explained by referring to the diagram or chart made by the meter which is in dispute.

The Patent Office reports show numerous devices for securing the record of the ammeter needle on a moving strip of paper by the use of a siphon pen or pencil. In all such cases, however, the element of friction is so apparent as to make their use prohibitive.

The patent granted to W. C. Patterson, No. 333,779, issued Jan. 5, 1886, and another to myself, No. 406,678, dated July 9, 1889, are the only ones which cover the use of paper which is sensitive to light in combination with electrical measuring devices. I regret that my time will not allow me to describe several other meters which have been presented to the American public, as well as meters of recent foreign production. The subject matter is too extensive to include it all in one paper, and probably may be taken up at some future day and more fully presented.

The Loan Collection of Early Electrical Books and Apparatus at the New York Electric Club.

One of the most attractive features of the recent meeting of the American Institute of Electrical Engineers was the splendid exhibit made at the rooms of the New York Electric Club on the evening of the reception tendered by the club to the members of the Institute, the materials for which were gathered from the collections of Park Benjamin, Edward Weston, W. J. Hammer, Luther Stieringer, Thomas A. Edison, T. C. Martin, F. L. Pope, E. F. Gennert, Wm. Stanley, Jr., and others. It may safely be said that this collection surpassed anything of the kind that has ever been made in this country, and that it attracted the attention which it well deserved. The entertainment committee of the club, of which Mr. T. C. Martin is the chairman, deserves great credit for the successful work done in preparing this exhibit.

The book collection is worthy of special notice. These were ranged systematically in eight cases in the order best adapted to show the historical development of electrical science.

In the first case were the works which show the state of science at the time of Gilbert, many of them being the sources of his scientific education, and to which he frequently refers in his famous work "De Magnete." Of this work alone three copies were exhibited, all of the first edition (1600). One was from the library of Edward Weston, one from that of Dr. Lugo, and the third was loaned by Chas. L. Clarke, of this city. Among the books in this case may be mentioned Diogenes Laertius, 1490, believed to be the first printed book having any reference to the "amber soul"; Roberti de Valle, "Commentary on Pliny," 1495, containing a reference to the magnet; Agricola on "Metallurgy," 1549; Pliny's "Natural History," 1516; Hero of Alexander's "Spiritalium," 1575; Hieronymus Cardan, "De Subtilitate," 1558; Robert Norman, "The New Attractive," edition of 1720, a work originally printed in 1540; N. Cabeus, "Philosophica Magnetica," 1630; Galileo, "The Laws of Falling Bodies."

The second case contained works covering the period from 1644 to 1700, among which may be mentioned Sir Kinelm Digby's "The Immortality of Reasonable Souls," editions of 1644 and 1645; Sir Hugh Plat's "The Jewel House of Art and Nature," 1653; Kircher's "Magnetism," Rome, 1654; Gasper Schott's "Universal Magic," 1658; Robert Boyle's "New Experiment Touching Cold," 1683; "Mechanical Origin or Production of Electricity," by Robert Boyle, 1675; J. P. Wurflbanius' "What I Know about Salamanders," 1683, and many other curious publications containing historical matter of interest to the student of electricity.

The third case contained works bearing on the history of the pioneer days of static electricity, and among the authors represented by one or more volumes may be mentioned Hauksbee, 1709; Van Musschenbroeck, 1731; Bishop Wilkins, 1691; Robert Hooke, 1725; Mitchell, 1751; W. Watson, 1746; Desaguliers, 1742; F. Winckler, 1748; Beccaria, 1753; Belgrado, 1749, and Benjamin Wilson, 1746.

The fourth case contained works belonging to the period of Franklin, and this was represented by a number of Franklin's works of various dates from 1754 to 1774; Priestley, 1767; Sigaud la Fond, 1771; B. Lovett, 1774; Marat, 1782; Abbe Bertholon, 1783; Abbe Nollet, 1745, and Cavallo, 1777, 1780 and 1782.

The fifth period was designated as the period of Galvani and Volta. This case was particularly interesting because it contained five of Ampère's original treatises, bearing dates, respectively, 1820, 1822, 1824, and 1825. One of these contained copious annotations in the handwriting of Apmère. The next period was represented by historical matter relating to the beginnings of the electromagnet. Among the publications were those of Ferguson, 1770; Report by Franklin and others against Mesmerism, 1785; Æpinus, 1759, and a large number of the original publications of Volta and Galvani.

The development of the electrical industries was represented in the next case by works of Davy, Faraday, Sturgeon, Vail and Morse, the most interesting being Morse's annotated copy of the Bain telegraph suit, loaned by Mr. T. C. Martin.

In the eighth case was a variety of publications, among which the autograph copy of Gilbert attracted the most attention. The little book published in 1837, describing the Davenport motor, was shown in this case. As mentioned above, all the copies of Gilbert were of the first edition. The second edition was published in 1628, and in this connection the fac-simile title page of the second edition, on page 391 of this issue, will prove interesting to our readers, as will also the portrait of Gilbert reproduced from a portrait exhibited in the loan collection.

On the walls of the exhibition-room were shown autograph letters and portraits of Humboldt, Herschel, Faraday, Davy, Boyle, Priestley, Tyndall and Darwin, all from the collection of Edward Weston.

The Davanport electric railway was loaned by Mr. F. L. Pope, and added very materially to the completeness of the exhibit as representing the history of electrical progress in America.

An alternate-current transformer which, according to the label, was made and operated by Mr. Edison in 1878, was loaned by Mr. Stieringer. This was operated in 1878 from a Wallace-Farmer dynamo, the secondary being in circuit with about 20 platinum incandescent lamps arranged in parallel. Mr. Wm. Stanley loaned his original transformer used in the distribution of the alternating current in 1885 and 1886.

An interesting and curious series of lamp sockets and switches from the collection of Mr. Stieringer and a set of lamps and sockets loaned by Mr. E. F. Gennert showed very plainly the development of these pieces of apparatus.

Another splendid exhibit was made by Mr. W. J. Hammer, who loaned for the purpose about one-fifth of his large collection of incandescent lamps. This collection is of great interest and value, and has often been called into use in legal proceedings. It includes some of the rarest and choicest specimens of lamps in existence. Besides these lamps Mr. Hammer showed some early photographs, portraits of prominent electricians and some scarce electrical books.

Altogether the collection was a fine one, and called forth the admiration of the numerous visitors who inspected it. It would be well if such a collection were the property of the Institute instead of belonging to private individuals.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Thomson-Houston.—The Boston *Beacon* says that the Thomson-Houston Company has a considerable amount of securities which it proposes to offer to stockholders in another series at an attractive price.

European Welding.—It is said that the financial condition of London has prevented the placing of the stock of the new English concern, and the buyers of the European welding patents have kept their right to complete the purchase alive by making partial payments and standing interest charges. President S. Endicott Peabody, of the American Loan and Trust Company, who has been in London for several weeks on business connected with this company's affairs has, it is reported, made some new arrangement with the European syndicate, the details of which have not yet been made public. Mr. Peabody sailed for home last week.

Westinghouse.—It has been officially announced that over 40,000 shares of the Westinghouse stock have already been deposited under the plan of reorganization. No time limit has been fixed for making deposits, but may be later. The Pittsburgh *Chronicle* says: "The objections raised to some minor features of the scheme, and particularly the one proposing to exclude the non-assessing stock from participation in profits for an indefinite period, are such as might, if pressed in court, defeat the entire plan; hence Mr. Westinghouse prefers to postpone definite action until the ratio of assented stock is much greater than at present, and so great as to make it practically unanimous. This is accepted by Mr. Westinghouse's near friends and supporters as an indication of his desire to do nothing inimical to the best interests of the common stock, whether assenting or non-assenting."

The Erie Telegraph and Telephone Company's annual report for the year ended March 31 compares with the preceding year as follows:

	1891.	1890.		
Gross income	$791,084	$721,680	Inc.	$69,203
Expenses and dividends	765,617	719,259	Inc.	46,358
Surplus	$25,446	$2,601	Inc.	$22,845
Proportion of dividends received by Erie company	$208,470	$225,062	Dec.	$16,592
Dividends paid, 4 per cent.	192,000	192,000		
Surplus	$16,470	$33,062	Dec.	$16,592
Subscribers added	1,131	930	Inc.	201
Connected March 31	13,376	12,245	Inc.	1,131

The balance sheet, March 31, 1891, is as follows: Assets—Stocks, $4,935,000; unissued stock, $200,000; cash deposits for unpaid dividends, $1,761.50; dividends due, $53,156.37; accounts receivable, $4,219.52; cash, $4,884.55; total, $5,199,021.94. Liabilities—Capital stock, $5,000,000; unpaid dividends, $1,761.50; surplus $86,260.44; reserved for dividend No. 30, $48,000; notes payable, $63,000; total, $5,199,021.94. This report covers the business of the Cleveland Telephone Company, the Northwestern Telephone Exchange Company and the Southwestern Telegraph and Telephone Company. In April the Erie's sub-companies made a net gain of 113 subscribers.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, New York, on Saturday, May 23, 1891, in New York, Boston and Washington were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	80¼	80⅝
American Telegraph & Cable	100	14,000,000	....	84
Central and South American	100	5,000,000	145	....
Mexican	100	2,000,000	205	....
Commercial Cable Co	100	7,716,000	105	107
Postal Telegraph Cable	100	5,000,000	39	41
Edison General Electric Co	100	9,503,500	101	102
" " Deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,929,400	....	....
Edison Electric Illuminating Co.	100	2,567,800	76	...
United States Electric Light	100	1,500,000	30	....
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	44	44½
" " preferred	25	4,000,000	25½	25¾
" " Series C	10	400,000	....	....
" " Series D	10	120,000	7¼	7⅛
" International Co	100	1,000,000	....	....
Thomson Welding Co	100	1,000,000	....	....
" European Welding Co	100	1,000,000	....	60
Ft. Wayne Electric Co.	25	4,000,000	12	12½
Westinghouse Electric Co	50	5,000,000	14	14⅛
Detroit Electrical Works	..	.....	11⅜	12
Telephone:				
American Bell	100	12,500,000	199	200
Erie	100	4,800,000	48	....
New England	100	10,304,600	....	53
Mexican	10	1,280,000	1.00	1.10
Tropical American	10	400,000	50c.	....
Edison Phonograph Doll	10	1,000,000	50c.	1.00
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	....
Chesapeake & Potomac	100	2,650,000	59¾	64
American Graphophone	10	600,000	6⅛	6¾
United States Electric Light (Washington)	100	300,000	159	165
Eckington and Soldiers' Home Electric Ry	50	352,000	48	50
Georgetown and Tennallytown	50	200,000	58	61

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

Chicago	$230@$240	Cumberland	$80@ $82
Central Union	56@ 57	Wisconsin	118@ 120
Michigan	86@ 88	Bell of Missouri	160@ 165
Great Southern	30@ 3[illegible]	Iowa Union	20@ 22
Colorado	34@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell	40@ 43		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$104@$105	Chicago Edison Co.	$145@$150

AFFAIRS OF THE COMPANIES.

The Claysville (Pa.) Heat & Light Company will file its accounts and apply to the Court of Common Pleas for a decree of dissolution on the 8th of June.

The Southern New England Telephone Company held its meeting of stockholders recently and the old board of directors was re-elected. The stockholders ratified the action of the directors in bonding the company to the amount of $300,000 to secure its indebtedness.

The Hamburg Water, Electric Light & Improvement Company, at its last meeting, elected the following officers and trustees: Hon. T. L. Bunting, president; John F. Burke, vice-president, H. S. Spencer, secretary and treasurer; Jacob Peffer, superintendent; trustees, the Hon. D. N. Lockwood, H. D. Folinsbee, George M. Pierce.

The Moorestown (N. J.) Electric Light, Heat and Power Company held its second annual meeting recently and the following officers were chosen: President, E. W. Perkins; vice-president, J. S. Riehle, and secretary and treasurer, J. S. Rogers. Directors, E. W. Perkins, J. S. Riehle, J. S. Rogers, G. W. Heaton, Rufus Hill, Dr. Pusey Wilson, E. F. Benners, W. H. Roberts and J. T. Sullivan.

The Rocky Mountain Bell Telephone Company, of Butte City, Mont., made its annual statement recently. The assets are stated as follows: Licenses and right of way, $390,000; construction, $467,766; bells, $23,593.95; merchandise, $3,475.37; personal property, $5,422.99; accounts receivable, $10,234.36; stocks and bonds, $1,600; cash, $3,404.88; total, $905,456.57. The liabilities are placed as follows: Capital stock paid in cash, $410,000; stock paid in franchise, $390,000; surplus, $58,592.09; reserve, $38,572.77; outstanding toll, $269.52; accounts payable, $8,222.19; total, $905,456.57. The statement is sworn to by the president at Salt Lake City.

Baltimore, Md.—The electric light works of the International Telegraph District and Construction Company have closed down and nearly 300 merchants and manufacturers are without lights.

J. B. McNealis is president and E. M. Wilthaus secretary of the concern. The company has been in trouble for some time. An application has been made to the courts for a receiver. The stock holders will hold a meeting next week and decide if they will continue or not.

NEW INCORPORATIONS.

The Philadelphia Electric Service Company has been incorporated in Camden, N. J., and Philadelphia, Pa. The capital stock is $100,000.

The New Albany (Ind.) Electric Light, Heat and Power Company, with a capital stock of $75,000 has assigned to Charles A. Sowle. Estimated liabilities, $50,000; assets, about the same.

Eureka Springs, Ark.—The Eureka Springs Electric Light and Street Railway Company has been incorporated by Powell Clayton, L. H. Roots and R. C. Keram, to establish an electric light and power plant.

The Colorado (Tex.) Electric Light Company has been incorporated with a capital stock of $10,000 to erect an electric light plant; and the Belton (Tex.) Electric Company has been awarded the contract for the same.

Newport, Ky.—The Standard Construction Company, with a capital stock of $500,000, has been incorporated by D. R. P. Dimmick, P. Bird, H. W. Coleman and others. Their charter empowers them to erect an electric light plant.

The Paterson (N. J.) Electrical Manufacturing Company was incorporated last week. The object of the company is the manufacture of electric motors and other machinery operated by electricity. The capital stock is $100,000.

The Hagerstown (Md.) Heat and Light Company with a capital stock of $35,000, has been incorporated by E. W. Mealey, C. F. Manning and E. B. Knight of Philadelphia, Pa. The company will establish an electric light plant.

The Southern Emigration Improvement and Manufacturing Company was recently incorporated at Raleigh, N. C., with a capital stock of $40,000, and among the enterprises contemplated is the establishment of an electric light plant.

The Independent Lighting and Supply Company has been incorporated at Chicago, with a capital stock of $60,000, for the manufacture of lamps and stoves and furnishing electricity, gas or oil. Incorporators, G. S. Markham, B. A. May and E. G. Loomis.

The American District Telegraph Company was incorporated last week in Great Falls, Mon., by F. P. Atkinson, Jno. P. Dyas, and H. Sommers, with a capital stock of $30,000, divided into 300 shares. The principal place of business will be Great Falls.

The Chillicothe Water, Electric Light and Power Company, at Chillicothe, Peoria county, Ill., has been incorporated, with a capital stock of $50,000, to furnish water, heat, light and power. Incorporators, S. B. Hartz, G. H. Lucas and E. W. Wilson.

The Heesch and Ellerbeck Electric Company, of Salt Lake City, Utah, has been incorporated, with a capital stock of $10,000. John C. Heesch, Brigham M. Ellerbeck, Murray C. Godbe, Thomas R. Ellerbeck, Witton Ellerbeck, and Horace Ellerbeck are the incorporators.

The Belt Line Electric Street Railway, of Port Townsend, Wash., which was begun some time ago, has been reincorporated, and the road will soon be completed. It will be about four and a half miles long. The total cost will be $100,000. Julius S. Potter, H. C. Culver and others are interested.

The South Seattle Electric Street Railway and Motor Company has been incorporated in Seattle, Wash. James T. Lentzy, Ralph W. Emmons, Omar W. Stoner, Charles E. Hill and Job P. Lyon are the incorporators. The capital stock is $100,000, divided into 1,000 shares of $100 each.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, May 25, 1891.

Messrs. Himmer & Anderson have removed from 20 Vesey street to 123 Chambers street, where larger quarters have been secured.

The United Electric Company has opened offices at 40 Wall street, New York City, with Herbert Knight as general manager and Frank A. Ehret as treasurer.

Mr. James C. Duff, the theatrical manager, has brought suit for $7,500 against the Western Union Telegraph Company on account of a delay in delivering a dispatch, by reason of which he was arrested in Boston and suffered much annoyance.

Mr. Hiram J. Maxim, the well-known electrical inventor, was present at the annual meeting of electrical engineers. Mr. Maxim has been discussing flying machines with Prof. Langley. He said to a reporter this week: "If I can rise from the coast of France, sail through the air across the Channel, and drop half a ton of nitro-glycerine upon an English city, I can revolutionize the world. I believe I can do it if I live long enough. If I die some one will come after me who will be successful where I have failed."

About 50 delegates to the annual meeting of the Institute of Electrical Engineers visited the Crocker-Wheeler Motor Company's factory, on Fourteenth street, Thursday last, and were well repaid for their time and trouble. The Crocker-Wheeler company opened its factory for full inspection from top to bottom, first showing a line of motors of the same type from 1-12 h. p. up to 5 h. p., all doing admirable work. A case containing their special armatures of these same sizes was neatly arranged near the motors, and a board showing the different pieces of the armature was on the wall near by, while in the main room of the factory two machines were doing good work stamping out the iron used in their construction. Motors running ventilating fans, as used in factories, also small fans, motors running sewing-machines and pumping water (among others, two machines of ⅛ and 6 h. p. respectively, coupled direct, showing very slow speed) attracted general attention. Dr. S. S. Wheeler, president of the company, and Mr. Geo. W. La Rue, the secretary and general sales agent, were untiring in their efforts to please the visitors, and that they were successful was shown by the fact that all those present left reluctantly, and only because of the time limit fixed by the Institute for the inspection. L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, May 23, 1891.

Mr. Thomas C. Perkins, of the firm of T. C. Perkins & Co., of Hartford, was in town Saturday last.

The Erie Telegraph and Telephone Company will hold its annual meeting in New York City on June 9.

The Union Railway Company, of Providence, R. I., has been given permission to use the single trolley system on its Pawtuxet route.

Mr. Louis Magee, the European agent of the Thomson-Houston Electric Company, whose office is in Hamburg, Germany, has been in town the past week. He will leave for Germany on June 3.

The Thomson-Houston Electric Company will put in the new electric plant at Springfield, Vt. Twenty street arc lights will be furnished and arcs and incandescents will be provided for commercial use.

Harvard College has been presented with an electric light plant which will be installed during the coming summer vacation. This will be a great benefit to the central library in Gore Hall which has never been lighted artificially on account of the great risk from fire.

Newton, Mass.—At the meeting of the Newton board of aldermen last week the hearing on the rescinding of the order to re-locate the track of the Newton street railway was opened. The hearing was lively, and sensational charges of bribery were made against the railway officials.

The Bell Rock Electrical Conductor Company gave a private exhibition of the working of its new wire-covering machine at the works in Malden, last week. About twenty gentlemen from Boston and vicinity were present and were more than favorably impressed. The company intends to commence operations in a short time, and a very successful future is assured.

Salem, Mass.—The aldermen last week gave a hearing on the petitition of the Essex electric road for permission to run over the track of the Naumkeag to the Willows. H. P. Moulton appeared for the Naumkeag road, and stated that if the Essex road attempted to cross their track they should question the legality of their right to run there by electricity in the courts, as they claimed the Essex company had not got legal permission to do so.

The Fall River, Mass., board of aldermen gave a hearing to the petitioners who propose to construct and maintain an electric freight railway nine and one-half miles through private lands and two and one-half miles through the streets of the city. Strong opposition was made, local capitalists claiming that the right granted by the Legislature is very unusual and extraordinary, and that the franchise asked for is too valuable to be given away unless all the plans of the company are laid bare. C, A. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY TRUST BUILDING, PHILADELPHIA, May 23, 1891.

Mr. S. Ashton Hand, of Philadelphia, a widely-known mechanical engineer, a member of the American Society of Mechanical Engineers, and lately general superintendent for Morris, Tasker & Co., has joined the forces of the Equitable Engineering and Construction Company. Mr. Hand will take entire charge of the mechanical engineering department of the Equitable company, whose offices are in the Drexel Building, Philadelphia.

Mr. M. S. Shapleigh, of this city, has brought suit against the Chester Electric Light Company and its officers, of Chester, Pa., also against Mr. Abner Dedir, of Burlington, N. J., for infringement of the Shapleigh patent safety cut-outs. The defendants are purchasers of the "Spring Clip" cut-out made by the Emerson Electric Mfg. Co., of St. Louis, Mo. Mr. Shapleigh's counsel are: Mr. John R. Bennet, of New York, Mr. Randal Morgan and Mr. M. W. Collet, of Philadelphia, Pa.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, May 23, 1891.

The Charles Munson Belting Company, of Chicago, was represented at Carondolet this week by General Tourist Baugher.

The Citizens' Electric Light Company, of East St. Louis, Ill., has just added another 80-light "Wood" arc dynamo to its station.

Mr. F. W. Weir, the general manager of the Western department of the Falls Rivet and Machine Company, was in St. Louis, Mo., this week.

The Municipal Electric Lighting and Power Company, St. Louis, Mo., has installed ten 80-light "Wood" arc dynamos during this month.

Col. L. W. Burnham, of the Electric Gas Lighting Company, of Boston, is in the city en route home from a trip through the northwest and along the Pacific slope.

Mr. E. E. Keeler, formerly manager of the Chicago office of the North American Construction Company, is now connected with the Chicago office of the Fort Wayne Electric Company.

The Electric Train will carry the Chicago morning papers to the summer visitors at Lake Geneva, Wis., if certain experiments now being carried on should prove successful.

Storage Battery Traction.—Experiments are now being carried on with the view of operating an electric motor car on the railway line between Lyons and Sterling, Kan., with storage battery equipment.

Mr. H. Dewar, of the Russell Electric Company, of Boston, Mass., returned to Chicago this week from a flying trip to Fairfield and Dubuque, Ia., where he has been installing the well-known Russell arc lamps.

Mr. Frank Stewart, of the Westinghouse Electric & Manufacturing Company's railway department, has just returned to Chicago from a successful trip through Montana, along the coast, and in Utah and Colorado.

The Electric Merchandise Company, of 11 Adams street Chicago, has been awarded the contract for 40 miles of electric street railway in Memphis, Tenn. The company is to install the complete overhead equipment, including rail bonds and poles for the road.

The Electric Merchandise Company, of 11 Adams street, Chicago, is the recipient of the order for the complete overhead equipment rail-bonds, etc., for the Memphis (Tenn.) street railway system, covering about sixty miles of track. Credit is due jointly to Mr. A. H. England and Mr. P. B. Dean.

Chief Burnham advertises this week for bids for the construction of the Electricity Building. It must be completed before April 1, 1892. Contractors have until June 1 to send in their bids. The building will be 700 × 350 feet and is estimated to cost $300,000. Chief Burnham now has fifty draughtsmen at work developing the architect's drawings into working plans. The buildings for the women's display and for the horticulture and manufactures departments will be next advertised.

The Hill Clutch Works, of Cleveland, O., has recently added a 40-inch lathe to its extensive machine shops, and also an enormous power press that will instantly straighten steel or iron shafting up to 10 inches in diameter, and which is probably one of the largest machines of the kind in the country. A new set of double planers has also been added, and the Hill works are now engaged on some of the heaviest work in the country, the 84-inch clutch couplings and rings that they are building for the East End company weighing nearly seven tons.

Mr. C. A. Brown's many friends—and they are legion—will be interested in learning that he has formed a partnership with Mr. George Barton, of Chicago, to go into effect on July 1, 1891, and the new firm will do a general law business, making a specialty of trade mark and patent law. Mr. Brown will not immediately sever his connection as manager of the Western Electric Company, but will gradually turn over his duties to a successor. For years Mr. Brown has been the popular, progressive leader among the electricians of the West, and has been closely identified with the organization and growth of the National Association and the local clubs.

The Bain Electric Manufacturing Company, of 47 and 49 South Jefferson street, Chicago, Ill., reports an encouraging amount of business, especially in orders for small motors and incandescent dynamos and large power generators. Recent shipments of electric machinery practically covered the continent; a 50 h. p. generator going to the East, a number of four horse-power motors to the far West and an incandescent dynamo to the South. Mr. Bain gives credit for some of this trade to the good work done by the excellent catalogue which he issued some time since, and which has been of so much assistance to purchasing agents, engineers and others having the handling of electrical machinery, owing to the amount of practical information contained therein.

To Save the Fair $1,000,000.—Mr. John P. Barrett has a plan for saving $1,000,000 in lighting the Columbian Exposition grounds. The estimate for lighting the grounds as turned in from the Construction Department is $1,700,000. The estimate made was on the supposition that the Exposition should, at its own expense, put in the entire plant. Prof. Barrett's idea is that electric lighting shall be made a part of the exhibit. There will be fifteen or twenty electric companies making an exhibit at the Exposition. Prof. Barrett says that the exhibitors would willingly utilize their machinery to light the grounds. The plant of the electrical companies will be on the ground any way, says Prof. Barrett. That covers the cost of machinery. By letting the lighting contracts to these people, the cost will be reduced. F. DE L.

DETROIT, May 23, 1891.

Mr. W. F. Davidson, of Port Huron, Mich., was registered at the Cadillac House this week.

Mr. James A. Campbell, of Detroit, formerly the general manager of the Thomson-Houston Electric Company, is crowded with work in his new construction business.

The Electrical Construction Company, of Chicago, has moved its office and factory from 175 Randolph street to 43 and 45 Franklin street, between Randolph and Lake streets.

The Detroit Exposition, at Detroit, Mich., has converted the art department into an electrical section, and will endeavor to have an unusually handsome display this year.

Mr. C. H. Rockwell, general manager of the Buckeye Electric Company, Cleveland, O., visited Detroit this week while en route to Lansing to meet his brother, who is a member of the State Legislature.

The Scandinavian Engineering Society.—About 30 Scandinavian engineers—civil, mechanical and electrical—met at the Sherman House last week to form a permanent organization. It was decided to call the body the Scandinavian Engineering Society of Chicago. Final organization will be completed a week from next Thursday.

Mr. William M. Belt, who held a responsible position with the Thomson-Houston Electric Company, was stricken with paralysis last week, and died from its effects at his residence, 252 Lincoln avenue. Mr. Belt came here a few years ago from St. Louis. He was a member of the California Pioneers' Society, being one of the few Chicago residents who crossed the plains in '49, and a member of Acacia Lodge, F. and A. M., of Lawrence, Kan.

DENVER, Colo., May 21, 1891.

Mr. Sterns, of the Mountain Electric Company, left last week on a European trip.

Mr. Owen Ford, superintendent of the Denver (Colo.) Edison Company, is at present in Ogden, Utah.

The Denver Edison Company is installing two No. 60 generators at Colorado Springs for the electric railway there.

The Denver (Colo.) Tramway Company is changing the Berkeley Motor Line from steam to the electric system, and is to use 26 Brill-Maxim trucks, equipped with Thomson-Houston slow-speed motors.

Mr. F. F. Downs, formerly Western representative of the Wenstrom Consolidated Dynamo and Motor Company, is back from a two months' stay in the East. It is understood that he proposes to close his business here, and will be engaged in the placing of bonds and securities for electric light and railway companies. His friends here are wishing him the best of success in his new departure.

PORTLAND, Ore., May 19, 1891.

The Willamette Falls Electric Company, of Portland, Ore., will shortly install a one-hundred light Excelsior arc dynamo.

Chehalis, Ore.—The Edison Electric Company has just sold the city a 70-light incandescent dynamo, which will be placed with the local Thomson-Houston arc-light plant.

The Thomson-Houston Electric Company, through its Northwestern agency in Portland, Ore., has recently made the following sales and installations: An isolated incandescent plant of 500 lights in the Ladd Building, of Portland, Ore.; one 35 arc-light dynamo for the city of Chehalis, Ore., and one 50 arc-light machine to the Home Electric Company, of Seattle, Wash.

WACO, Tex., May 20, 1891.

Electrical matters are progressing in the South, especially at this point. Capitalists that have money invested in the rolling stock of street railways are beginning to see that an electric motor is easier to control and maintain than a mule, and that electrical power is cheaper than mule power and is less objectionable. The Waco Citizens' Street Railway Company now has four different lines in operation here, aggregating something like five or six miles of trolley lines, which it is extending as fast as possible with its large force of men. The company has the Westinghouse system of motors and generators. The central station is equipped with four 40,000-watt generators, driven by two Hamilton-Corliss compound

engines. The cars carry two motors of 15 h. p. each. The Waco Street Railway Company has purchased lots and is building track for a new electric railway, and contemplates using the Thomson-Houston system of motors and generators. The company intends also to bid for a share of private and city lighting, despite the fact that the old company bid in the last city light at 90c. per month each, probably the cheapest bid for arc lights in the country. S. A. Hobson and Park Heaton have established an electrical supply office and intend to supply the local trade with electrical goods. The City Council, alive to the fact that the city has some rights and privileges and a fire-alarm system to look after, has secured the services of Mr. R. W. Gray, an electrician, to draft an ordinance defining the regulations to be applied to the different companies and to extend the fire-alarm system. Waco is the central city and can boast of the cheapest light in the State. L. S.

SOUTHERN NOTES.

NORFOLK, Va., May 23, 1891.

Marlan (Tex.) parties are making an effort to establish an electric light plant.

Columbus, Ga.—The Columbus Iron Works has added an electric welding equipment.

Dayton, Tenn.—A franchise has been given to G. J. Morse to erect and operate an electric light plant.

Aransas Harbor, Tex.—It is reported that a contract has been awarded for the erection of an electric light plant.

Colorado, Tex.—An electric light plant is to be erected by the Colorado Refrigerator Company, recently incorporated.

Palatka (Fla.) parties are making efforts to organize a company for the purpose of establishing an electric light plant.

Winston, N. C.—The Winston Electric Railway Company is preparing to extend its street railway a distance of two miles.

Shendun, Va.—The new electric light and power plant is approaching completion. The poles are now being put in position.

Kanawha City (W. Va.) parties are organizing a company for the purpose of building an electric railroad to Charleston, W. Va.

Cuero, Tex.—A movement is on foot looking to the organization of a company for the purpose of establishing an electric light plant.

Mount Airy, N. C.—An electric light plant will be put into the new hotel being erected by the Granite City Land and Improvement Company.

Rockdale, Tex.—Mr. M. P. Kelly, representing an Eastern syndicate, has perfected arrangements for the erection of an electric light plant.

Little Rock, Ark.—The Capitol Street Railway Company is preparing to erect an electric power plant that will cost $46,000, and be 90 × 300 feet in dimensions.

Richmond, Va.—The Richmond Electro-Plate Works has recently completed its new building, to be occupied by its gold, silver, nickel, and brass plating plant.

Waco, Tex.—The Waco Electric Railway and Light Company has adopted the Thomson-Houston system, and is preparing to commence work on its new electric railroad.

Atlanta, Ga.—The Atlanta Consolidated Street Railway Company has recently purchased the Metropolitan dummy line and will convert the same into an electric system.

Salem, Va.—The electric light plant of the Salem Electric Light Company is nearly completed, and the system will be ready to go into operation during the coming month.

Mobile, Ala.—The city council has appointed a committee to ascertain the cost of lighting the city by electricity, and it is said to be probable that the city will establish a plant of its own.

Pikesville, Md.—An electrical railroad is to be constructed by the Pimlico & Pikesville Railroad Company, recently organized, and to whom authority has been granted by county commissioners.

Union City, Tenn.—An election has just been held, favorably deciding the question of issuing bonds for the erection of an electric light plant and the inauguration of other municipal improvements.

Washington, D. C.—Mr. George Dewey is inviting proposals, until June 16, for supplying electric generators, search-light and signalling apparatus for the New York and Portsmouth, Va., navy yards.

Jackson, Tenn., it is stated will so amend its charter as to authorize the issuing of $75,000 of bonds, for the purpose of establishing an electric light plant and perfecting other municipal improvements.

Annapolis, Md.—The city council has been petitioned by Douglas H. Thomas, J. H. Fisher, W. C. Sedder, H. C. Howard, and J. E. Myers, of Baltimore, Md., for a franchise to build and operate an electric railroad.

Nashville, Tenn.—The Maple Wood electric railroad is a new electric line two and one-third miles in length, which is shortly to be constructed under the superintendence of Mr. Eugene T. Lynch, of New York city.

Birmingham, Ala.—The Birmingham Railway and Electric Company is reported to have recently awarded a contract to the Thomson-Houston Electric Company, of Boston, Mass., for furnishing an electrical equipment.

Montgomery, Ala.—A company, with a capital stock of $200,000, is being organized by W. W. Marmaduke, of Washington, Ind., and others, for the purpose of constructing an electric railroad and laying off a new subdivision.

Pell City, Ala.—The Pell City Iron and Land Company is interested in the building of an electric railroad from Pell City to some point on the Coosa river. It has been practically decided to adopt the Thomson-Houston system, so it is stated.

Raleigh, N. C.—The North Carolina Railway Commission has issued an order to the effect that, on and after the first of June, all telegraphic messages, having their origin and termination within the State of North Carolina, will be charged as follows: Ten words or under, 25 cents; over ten words, 2 cents each additional word.

V. N. B.

ENGLISH NOTES.

(From our own correspondent.)

LONDON, May 13, 1891.

Electric Lighting Provisional Orders.—Some 50 provisional orders have been issued this year by the Board of Trade, a very large number of which are municipal orders. Many of the orders are merely extensions of those already granted.

St. James and Pall Mall Company.—This company announces that its receipts from current sold during the quarter ending March 31 amounted to £9,632, as against £1,818 for the corresponding period last year. This means that it sold 330,000 B. T. U. during the first quarter of the present year, as against 62,000 in 1890, or, in other words, an increase of 432 per cent.

Glasgow.—The corporation of Glasgow, after long dallying with the question, is apparently about to go in for municipal electric lighting. Reports have been received on the subject from Sir Wm. Thomson, Prof. Jamieson and Mr. R. E. Crompton. It is proposed to spend some £60,000 as a commencement and to adopt the three-wire system with accumulators. It must be understood that the matter is still under discussion, but the probability is that the scheme recommended by the engineers and the special committee of the Town Council will be ultimately adopted and vigorously carried out. It may be mentioned that the Glasgow municipality owns the gas works supplying the city.

The Anglo-American Telegraph Company and the Compagnie Francaise de Telegraphes de Paris a New York.—After dragging along for many years the lawsuit between these two companies, which arose from the withdrawal of the French company from the "pool," has come to a termination by the decision of the Conseil d'Etat in favor of the Anglo-American Company. The French company having been captured by the Mackay-Bennett Company, withdrew from the "pool," and hoped to avoid paying what it owed to the other companies by securing a declaration from the French government that participation in the "pool" was beyond the company's powers. This device has not, however, succeeded.

Electric Lighting of the City.—Rapid progress is being made in connection with the electric lighting of the city of London. The streets are up in all directions and gangs of workmen are employed in the (to the public) interesting occupation of laying Callender-Webber bitumen conduits. Here and there electric lighting standards have been erected with the view of eliciting public opinion as to their suitability, though how that public opinion is to make itself felt is not stated. Perhaps it is intended that the least suitable ones shall be demolished and the most suitable left, on the principle of the survival of the fittest. The Brush company's station at Bankside, across the river, is practically completed and the dynamos are being got into position. The station of the Laing, Wharton and Down Construction Syndicate at Tower Hill is approaching completion and the first of the street lighting is expected to take place early in June.

Railway Train Lighting.—An interesting paper on this subject was recently read before the Institution of Civil Enginers by W. Langdon, of the Midland Railway Company. Mr. Langdon pointed out that the lighting of carriages was now a-days carried out with a view of affording the luxury of reading, and not, as in the early days, merely to enable travelers to enter and leave the carriages without inconvenience. He gave a brief résumé of the history of train lighting by electricity in this country, which commenced in October, 1881, by the lighting of the Pullman express from London to Brighton. This was followed in 1883 and 1884 by an ingenious device of Mr. Preece applied to some trains on the London and South Western Railway. Mr. Preece used the movement of the train to compress air into a chamber, and the air so compressed was used to drive the dynamo. Since that date the Great Northern company, the London and North Western company and the Midland company have all tried various systems of train lighting by electricity. At the present moment the total number of electrically lighted vehicles in this country amounts to over 400, the system generally employed being the driving of a constant current dynamo situated in the guard's van from the axle, the current being used to charge accumulators off which the lamps are run. In one or two cases, however, the current is produced by a dynamo driven by a Brotherhood engine fixed to the tender and supplied with steam from the boiler of the locomotive. The Midland company, in deciding the equipment of some express trains running between London and the North, laid down most onerous conditions involving absolute independence of the lighting arrangements of each carriage and the utmost simplicity with regard to connections and couplings. These conditions have, however, been successfully complied with by their engineer, Mr. Langdon. The current is usually supplied from the dynamo in the guard's van to accumulators in *each carriage*, so that whenever a carriage is detached from the train the lights are extinguished. Mr. Langdon is of opinion that the cost of oil lighting will be found to work out at between ½d. and 1d. per lamp hour (8 c. p.), that of compressed gas at over ½d. per hour, while the actual cost of electricity as used on the Midland Railway did not greatly exceed ¼d. per lamp hour.

London-Paris Telephone.—Although conversation between the central telegraph office of London and that of Paris has proved an unqualified success, as soon as the high-resistance gutta-percha covered subterranean lines on the French side and our own underground lines were added to the main line, the voice was muffled, and conversation, while still possible, could scarcely be termed practicable. The only instrument which seems to have rendered conversation between a London and a Paris subscriber possible was the "Roulez" apparatus, with modified internal connections. The "Roulez" microphone consists of a vibrating diaphragm of carbon, at the back of which is a carbon block with its face covered with a sheet of cardboard, which acts as an insulator. The plate and block insulated from one another in this way constitute the two poles of the microphone. The current gets from one pole to the other across fragments of incandescent lamp filaments arranged in three hollows cut out of the carbon block, holes being also pierced opposite these hollows in the cardboard. Instead of the receiver and the secondary of the induction coil being placed in series in the usual way, they are placed in parallel across the line, a special key permitting either the receivers or the secondary to be placed in circuit *separately*, but not simultaneously. In the experiments between the Paris observatory and the Treasury at London, a battery of ten Lalande cells arranged in series was used with an ordinary "Roulez" instrument. This battery produced deafening crackings in the receivers and conversation was practically impossible. With a modified instrument, however, the voice was loud and clear, and one could even keep the receivers at some little distance from the ears and still perfectly understand what was being said. This modification of the usual connections seems therefore to possess undeniable practical advantages, and applied to the "Roulez" apparatus it increased the intensity of the sounds received at the observatory and at the Treasury by four to one. This device, however, possesses two drawbacks. It involves the use of a key and it is impossible to cut into the conversation of one's correspondent; you cannot make him hear as long as he is transmitting. The key is fitted in the handle of one of the receivers and it is manipulated with the thumb of the right hand. It is pressed down when transmitting and freed when listening. This very simple manœuvre is, it is said, easily learnt, and after two or three conversations it is carried out automatically. The impossibility of breaking into the conversation seems to me, however, a real disadvantage. Although one might soon acquire the habit of properly manipulating the apparatus, it is also possible to imagine that excited, uninitiated individuals, by keeping their keys in synchronism, might converse *ad infinitum* without getting a word through.

The Metropolitan Electric Supply Company.—The Metropolitan Electric Supply Company, the second largest company in London engaged in the supply of electricity, has just declared a quarterly dividend at the rate of 4½ per cent. The authorized capital of the company is half a million, and of this £368,000 has been called up and expended. One low-tension storage battery and three high-tension alternate current stations are now at work, and over 60,000 8 c. p. lamps are connected up, while a fourth station is in course of erection to supply current to the populous district of Paddington. Some 40 miles of iron-pipe conduit and 90 miles of cable have been laid down, and so far not a single serious fault has occurred, although the pressure of 1,000 volts is always on. At the meeting of the shareholders on Wednesday last the chairman of the company, Sir John Pender, who seems to have thrown himself into the electric lighting enterprise with as much vigor as he did into submarine telegraph enterprise some five-and-twenty years ago, made a speech of considerable interest. The discussion on Mr. Swinburne's most recent paper at the Institution of Electrical Engineers brought out the fact that two at least of the three alternate-current companies in London contemplated changing over to the transformer sub-station system at no distant date, and now we have it on the authority of the chairman that the Metropolitan Company "has for a long time been giving the matter careful attention, and has all along had in view the ultimate adoption of transformer sub-stations." The Metropolitan Company has been of great assistance to the Ferranti people during the past winter, temporarily supplying current to many of the London company's theatrical customers while the damage caused by the Grosvenor Gallery fire was being made good, and Sir John Pender took advantage of this fact to draw a comparison between the two systems. *The* great advantage, to his mind, of the Metropolitan Company's system of comparatively small *central* stations as compared with the London Company's single colossal *eccentric* station, is the diminution of the risk of a complete breakdown. All the Metropolitan Company's stations are connected together, and during the hours of light load a single station is alone at work. As to injunctions, Sir John relies on good machinery and effective smoke-consuming apparatus to minimize that evil. The experience of the first fifteen months' working convinces the engineers of the Metropolitan Company that the average income per eight candle power lamp wired cannot be expected to exceed 12s. per annum; that is to say, at 7½d. per Board of Trade unit, each lamp wired may be expected to consume 18.6 units; in other words, to be alight for 620 hours only. This is very different from the anticipations of many eminent authorities, but as the chairman said, it was in a way consolatory, since it meant that their plant had a much larger "lamp-wired" capacity than was generally supposed. Most of the electric lighting companies supplying the metropolis have now had their annual meetings, and the speeches of the chairmen show pretty clearly that while there *is* money in electric lighting, its profits are not likely to excite envy.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Compound Winding.—Will you please inform me of the theory and practice of compound winding for dynamos? I. A. T.

We would refer you to the series of articles: "How to Wind the Magnets for Shunt, Series and Compound Dynamos," by Carl Hering, beginning in THE ELECTRICAL WORLD of Jan. 16, 1886.

Incandescent Lamps on Arc Circuits.—How many 50 c. p. incandescent lamps can I use in place of one arc lamp of 1,200 c. p. without increasing the resistance of the circuit? How many 100 c. p. lamps? READER.

About three 50 c. p. lamps or two 100 c. p. lamps. When making inquiries always give complete data.

Charging Accumulators.—Kindly advise me through your valuable paper which is the best method of connecting up 18 Hussey bluestone cells to charge three 120-ampère hour accumulators.

H. C. L.

When charging with low electromotive force it is best to place your accumulators in parallel and to arrange your cells, say in two series of nine each in parallel.

Series Connection.—Will you please inform me in regard to the following questions: (1) If two dynamos (shunt wound), each designed for an E. M. F. of 200 volts and a capacity of 20 ampères, were connected in series, would the arrangement raise the voltage on each machine to 400 volts? Would it increase the pressure through the generators to 400 volts? (2) Supposing the pressure of the mains to be 400 volts, could you connect in such circuit two motors wound for 200 volts multiple series, and would the current of 400 volts be then flowing through the motor armatures? (3) Would the ampères increase also? V. O. B.

(1) When generators are connected in series the resulting electromotive force or difference of potential between the two outside mains is the sum of the respective pressures of the generators. When in series each generator is doing exactly what it would do individually. (2) Yes. (3) The number of ampères of current through a given resistance is always the same with a given pressure in volts. As each motor individually requires 200 volts pressure, when you have two such motors in series the electromotive force required for each motor is the same as before, but 400 volts E. M. F. is then required between the extreme terminals; that is, the positive pole of one motor and the negative pole of the other. Since, then, the pressure at the terminals of each motor is not increased, the ampères of current will be the same as though the motor were run singly on 200 volts E. M. F.

Submarine Telephony.—Will you please tell me if there has ever been any communication by telephone between America and Europe? E. T. S.

There has never been any such communication. The difficulty with submarine telephony is the fact of considerable electrostatic capacity in the cable; the result of this being retardation and deformation of the electrical impulses transmitted. If a line could be made of very, very low resistance, so that the electric currents would have the freest possible discharge, the evil effect of this capacity would be in part done away with. The relation between these two things has been determined in a somewhat empirical way. Calling the total resistance of a telephone line R, and its total capacity in microfarads K, successful speaking with our present instrument is really an impossibility when the product $K R$ of the resistance of the line in ohms by its capacity in microfarads is greater than about 10,000. In the very best Atlantic cable $K R$ equals somewhere near 3,000,000; so that unless there should be somewhat totally new developments in telephony, we can see at once that successful telephony across the Atlantic is very improbable, on account of the enormous cost of a conductor of low resistance and capacity, if for no other reason.

Conception of Volts Pressure.—Will you please give me some information upon the following points: (1) If a man takes respectively in each hand a wire of a 500 volt circuit in which is flow-

ing at the time a current of 200 ampères, will he receive a stronger shock than if he takes in each hand a wire of a 50-volt circuit in which is flowing 50 ampères? (2) Also what will be the result with circuits of 110 volts pressure? (3) What is the resistance of the human body? (4) By what method does the designer compute the number of lines of force generated by a certain number of ampère turns? (5) How is the point of saturation found? W. D. L.

(1) Drawing things finely, the man would receive the stronger shock from the 50-volt circuit in which the smaller current is flowing as he grasps the wire. But the shocks would be practically equal from both circuits, as the pressures of the circuits are equal, except for a slight possible drop in E. M. F., which might occur in the circuit carrying the larger current. From Ohm's law we get correct conceptions of current electricity. (2) With 110 volts pressure the current passing through the body would be a little over twice as great as in the former examples. (3) It is impossible to give even an average resistance of the human body. (4 and 5) For full information upon these subjects we would refer you to Prof. Silvanus P. Thompson's "Lectures on the Electromagnet."

News of the Week.

THE TELEGRAPH.

New Telegraph Line to New Orleans.—The Postal Telegraph Company has recently completed a very fine and substantial line from Indianapolis to New Orleans, passing through the cities of Louisville, Nashville, Memphis, Vicksburg, Jackson and intermediate points. The office in New Orleans is expected to open within 10 days.

"Early Days of the First Telegraph Line," by Mr. Stephen Vail, son of Alfred Vail, is to appear in the June number of the *New England Magazine*. The author's father, Alfred Vail was associated with Prof. Morse in the first inventions in the field of telegraphy, and additional interest is lent to the article by the claims put forth by Mr. Vail in behalf of his father's alleged share, in the perfecting and making of practical use the receiver and transmitter now adopted by all countries.

THE TELEPHONE.

Forest, Ont.—A telephone line is being constructed between Sarnia, Ont., and Forest.

Knoxville, Tenn.—The Southern Bell Telephone Company is reported making preparations to erect a telephone exchange building to cost $25,000.

Bloomfield, Fla.—A company is trying to get sufficient stock taken to build a telephone line to connect with the central office at Leesburg, where several lines are to be built soon.

Fargo, N. D.—The Fargo telephone exchange is to be reconstructed and made almost entirely new. Copper lines are to be run west 90 miles, connecting Mapleton and Casselton with that city.

The Piscataquis (Me.) Central Telephone Company has been organized and a line will be at once constructed from Foxcroft, Me., to the villages of Sangerville and Guilford, Me. As fast as desired other towns are to be brought into speaking relations with the Piscataquis centre.

Parkhill, Ont.—The town council recently held a special session to consider the application of the Parkhill Telephone Company for permission to put up poles along the streets of the town, to carry its telephone wires. The request of the company was granted, and there will soon be telephone communication between Parkhill and Grand Bend, Greenway, and other places north.

Baltimore, M. D.—The telephone company, which has secured the right to place its telephones in this city by obtaining the subway right for the metallic circuit, has made this subway large enough to serve for all underground wires, whenever they may be ordered down, and has thus virtually formed another company which will rent space in this subway to all who need to use it. This will not be done until after the telephone wires have been located.

THE ELECTRIC LIGHT.

Shenandoah, Ia., is to erect a municipal electric light plant.

Homer, Ill., is still fighting for a municipal electric light plant.

Labeeland, Fla., is soon to commence operations on its electric light plant.

Shushan, N. Y.—The new electric light plant will be ready for running about July 1.

Cuyahoga Falls, O., has decided in favor of an electric light system for the town by a vote of 299 to 39.

Butte City, Mont., has closed a lighting contract with the Butte Electric Light and Power Company.

Fitchburg, Mass., City Council is to advertise for bids for a less expensive municipal system of electric lighting.

Stoughton, Wis., will have an electric light plant shortly. Mr. J. S. Nutson is at the head of those in favor of the project.

Grand Rapids, Mich.—The town council committee will advertise for bids for municipal electric lighting at an early date.

Cape May, N. J.—A contract has been given for the lighting of Cape May by electricity during the coming season. It will cost $3,720.

Lehighton, Pa., will be lighted by 50 electric lights at an annual cost of $750, the town council having authorized the improvement last week.

Oyster Bay, L. I., is to have an electric light plant. Mr. D. D. Smith is the principal one interested, and will endeavor to secure a franchise at once.

Woodbury, N. J., has contracted with the Woodbury Electric Light and Power Company for 43 street lights, to run on the Humphreys moonlight schedule.

Audubon, Ia., has let the contract for the construction of an electric light plant with a 750-light dynamo to the National Electric Manufacturing Company, of Eau Claire, Wis.

Peoria, Ill.—The Jenney Electric Light and Power Company agrees to light the city this year, 80 lights of 2,000 c. p. each, for $6,200 a year, to be paid in monthly installments.

Deer Lodge City, Mo.—M. J. Bielenberg, Howard H. Zenor, Lee Mantle and Charles S. Warren have a contract for the construction and maintenance of an electric light plant.

Albina, Ore.—The Albina Light and Water Company lighted the suburb of Multnomah last week. The company expects to place many additional circuits in Multnomah County.

The Tonawanda and Wheatfield Electric Light Company has been awarded the contract of lighting the streets of North Tonawanda, N. Y., with electric lights for the ensuing year, at $90 a light.

Tacoma, Wash.—The Commercial Electric Company, which has for some time been negotiating for its plant equipment, has now commenced operations upon the station, and it is expected that the plant will be ready to run this fall.

Springfield, Vt.—The Springfield Electric Company, which has but recently organized, will put in a Thomson-Houston plant. The company has contracts for 20 street arcs, and will furnish both arcs and incandescents for commercial uses.

Elizabeth City, N. C.—The electric light works were totally destroyed by fire last week. The flames started between the boiler and fuel room, and in a remarkably short time the entire plant was in ruins. There was an insurance of $5,000 on the plant.

Des Moines, Ia.—The city council has approved the contract made by the board of public works with the local light company for 100 arc lights for street lighting, at $6 per month. The city has been paying the gas company $1,175 per month. This will cause a saving of $575 per month, or $6,900 per year.

Beverly, Mass.—The Committee on Lighting has contracted with the Beverly Gas and Electric Light Company for 80 arc lights, at a cost of 30 cents a night, to be lighted 300 nights a year for ten years. The company expects to complete the location and necessary arrangements within two months.

The Toledo (O.) Electric Company held a meeting last week to discuss plans for a new electric light station. The company intends erecting two fine fire-proof brick buildings, one story in height, as soon as a suitable location can be secured. The plans have not yet been decided upon, although several have been submitted.

The Shenandoah (Pa.) Electric Light and Power Company was granted a 10-year franchise at a recent special election. The company has a capital stock of $15,000, and will commence operations as soon as preliminaries are completed. The officers are as follows: President, Wm. M. Croan; vice-president, Geo. Bogart; secretary and treasurer, A. W. Murphy, and general manager, R. W. Morse.

The Capital Electric Light, Motor and Gas Company, of Boise City, Mont., began business in the summer of 1887, with a total capacity of 300 incandescent lamps and a paid-up capital of $8,500. With the completion of improvements now being made the capacity of the plant will be 2,500 incandescent lamps and fifty arc lamps, and the paid-up capital stock of the company will be $50,000. The company also furnishes electric power.

Springfield, Vt.—The Thomson-Houston Electric Company reports the sale of an electric light plant to the Springfield Electric Company. This is a stock company but recently organized. The company has contracted with the town to light the streets with some 20 arc lamps, and will also furnish lights both arc and incandescent, for commercial use. There will be two dynamos, one of the alternating pattern. Work on the station, it is said, has already started. A committee from the company was in the city last week inspecting the street-lighting system of Rutland, Vt.

St. Louis, Mo.—Mr. A. J. O'Reilly, superintendent of city lighting, submits the following comparative statement of the cost of lighting the streets and alleys of the city for the past five years:

Year ending April, 1887	$285,938.08
Year ending April, 1888	300,407.68
Year ending April, 1889	318,598.76
Year ending April, 1890	318,043.61
Year ending April, 1891	211,130.41

During the year ending April, 1891, there was an increase of 113 miles of streets illuminated over the mileage of any previous year.

The National Electric Light Association.—The Montreal meeting gives promise of being very largely attended, especially by Western members, and arrangements are now nearing completion to have a special sleeper leave St. Louis and Chicago and go by rail to Buffalo. Passengers will then take the steamer for Montreal, thus enabling the party to enjoy a night ride on Lake Ontario and a daylight trip down the picturesque St. Lawrence. It is understood that the Edison interests will be strongly represented at this meeting, and in the matter of papers it is reported that Captain Griffin, O. T. Crosby, Ernest Warner, Prof. Weston, Mr. Huntley and James I. Ayer will be prepared; while Mr. Huntley trusts that more interest may be aroused by the introduction of a question box. Mr. Warner's paper will cover the subject of "The Different Forms of Carbons used in Arc Lamps." At a meeting held by the citizens of Montreal on the 14th inst. various committees were arranged for. An effort will be made to secure as many attractions as possible.

THE ELECTRIC RAILWAY.

Charlotte, N. Y.—The Grand View Beach Railroad from Charlotte to Manitou Beach, a distance of eight miles, has started operation, and the system is giving satisfaction.

Washington, D. C.—The Wheeless Underground Electric Company, of Tacoma, Wash., has received a contract for the construction of twelve miles of its system in the city of Washington, D. C. Three miles will be underground, and nine miles overhead. The building of the road will include a massive bridge across the Potomac River.

Wilmington, Del.—Mr. George W. Stone, electrical engineer, of 211 Shipley street, has secured the contract for the new electrical railway. The road is to be two miles in length and is to have 25 cars with Sprague trucks. The work is under the supervision of Mr. Frank D. Sweeter, and will be finished at an early date.

Purchase of Electric Roads.—The Little syndicate has purchased the eight miles of street railway formerly owned by the Lincoln (Neb.) Rapid Transit Company, and now controls the entire street car line service in that city, some 50 miles in all. Mr. J. F. Barry & Co., of New York, the engineers who are equipping these roads electrically, expect to have 20 cars running by June 1 and 30 by June 15.

Underground Electric Railway between Prince Edward Island and New Brunswick.—A scheme is now being pushed forward for the construction of a tunnel between the above-named places. An electric railway is proposed. Some of the estimates are as follows: Tunnel of 12 feet, to be operated by an electric motor, $5,000,000; tunnel of 18 feet, to be operated with American rolling stock, $11,000,000; tunnel of 16 feet, $10,000,000.

Prejudice Against the Trolley System.—The Railroad Commissioners at Albany have refused to grant the application of the Coney Island & Brooklyn Railroad Company for approval of the board of a change of motive power from horses to overhead single trolley electric system upon that portion of its railroad between the corner of Franklin and Coney Island avenues, in the town of Flatbush, and the corner of Ninth avenue and Ninth street, in Brooklyn, along and upon Coney Island avenue, Fifteenth street and Ninth avenue.

St. Louis (Mo.) Cable Road Displaced.—Mr. Theo. P. Bailey, manager of the railway department of the Thomson-Houston Electric Company, at its Chicago office, reports the sale last week of electrical equipment for 45 cars, including 10 generators of 100 h. p. each, to the St. Louis & Suburban Railway Company, St. Louis, Mo. Mr. Bailey is elated over this contract, as it is a verification of the prediction made by him in the paper which he read before the Chicago Electric Club in November last, relating to the displacement of cable equipments by the substitution of electricity. This road has 19 miles of track, the power station being located so that there will be 12 miles on one side of the station and seven miles on the other side. The above road is the second to change from cable to motors since Mr. Bailey made his prediction. Grand Rapids, Mich., was the first.

The Duquesne Traction Company, of Pittsburgh, Pa., which began work upon its line a little more than a year ago and which has since got ready for operation twenty-eight miles of track, commenced the operation of the road on the 20th of May. Upon the first day of running 46 Thomson-Houston cars were put in use and everything worked well. The Duquesne road taps a large portion of the East End suburbs which have heretofore been unprovided with rapid transit facilities, and it will therefore take a great deal of the East End travel now carried by the Pennsylvania Railroad, Pittsburgh and Citizens' traction companies. It will also reach a point more than two miles farther east than the eastern terminals of the Pittsburgh and Citizens' traction companies, the end of its line being at Wilkinsburg, more than seven miles from the city proper. It is expected that pretty lively competition will be the outcome of the starting of the new road. Exceptional care was taken in the track work of the road. The foundations are composed of concrete, on which are placed oak ties to support the steel girder rails. The space between the tracks and for one foot outside is paved with Ligonier block. The building containing the station and offices is a substantial brick structure, and has an inside space 400 × 140 feet for the storage of cars. The powerhouse is at Ben Venue Station, on the Pennsylvania Railroad. This building is 150 × 130 feet, contains 12 dynamos of 100 h. p. each, and there is space for an additional generator capacity. There are two 600-h. p. and two 200-h. p. Corliss engines.

GENERAL APPLICATIONS OF POWER.

To Utilize Niagara Falls.—The Dominion Parliament at the present session will be asked to subsidize the Niagara and Queenston Land and Electric Company, which proposes to utilize, on the Canadian side, for manufacturing purposes, the wasted energies of Niagara Falls. It is proposed to bring the power to Queenston, as it will here have a fall of 320 feet instead of 160, the amount obtainable at the precipice. It is now recognized that the Heights of Queenston form the best place for using the power of Niagara. The company makes use of all the advantages naturally possessed by the district. Instead of tunneling through solid rock, as the Buffalo Power Company intends to do, the Queenston company proposes to use the bed of the Chippewa from a point above the Falls, and make a power canal for the remainder of the way after the Chippewa ceases to be available. When the power is generated at Queenston it will be the cheapest and most regular on the continent. The intention is to establish a milling and manufacturing centre, and in addition to transmit the power to other cities.

LEGAL NOTES.

The Tropical American Telephone Company, owners of the "Hynes" annunciator drop, patent No. 425,078, has begun suit in the United States District Court in New York city against the Western Electric Company and Irving Loveridge, its agent, for infringement of said patent by making and selling the "Hynes" annunciator drops, used in switch boards.

Telegraph Company Tax.—In the case of the Commonwealth of Massachusetts vs. The Western Union Telegraph Company, the validity was questioned of a law of Massachusetts which taxed the buildings, machinery, and other property of the company within the State, first ascertaining and deducting the amount of property of the company already assessed by municipal or other local authority. The Supreme Court of the United States upheld the validity of the law, but directed certain modifications to be made in the judgment of the State Court.

Thomson-Edison Interference Decided by the Commissioner.—The Commissioner of Patents, at Washington, D. C., has decided an important case involving the cutting out of a disabled incandescent lamp when employed in a circuit without interrupting the current traversing the remaining lamps. The contest involved applications of Thomson and Edison. The case of Edison depended largely upon a prior invention by him of devices described in older patents, which were held by the Commissioner not to involve the invention in dispute. The decision was in favor of Thomson, and sustained the finding of the examiners-in-chief, holding that Thomson was the original and first inventor.

Redress for Poor Telephone Service.—An action affecting telephone companies recently came before Justice Leonard in one of the English courts. The Western Counties Telephone Company sued Mr. Harry Wainscot, a solicitor, for £10, being the rent for the use of an instrument. On the other hand, the defendant set up a counter claim of £10 on the ground that the service had been frequently interrupted. He claimed that he had been subjected to much annoyance in the practice of his profession owing to the irregularity with which the plaintiffs had performed the work they had contracted to do. Justice Leonard awarded the plaintiff £10 and the defendant £5 on the respective claims, on the ground that he considered the defendant had not received the service the company had contracted to supply.

Power of a City to Permit the Operation of Electric Cars.—An important decision was rendered by the Supreme Court of Michigan in the case of the Detroit City Railway Company vs. Mills et al. In this case it appeared that the appellees, property owners on an avenue on which an electric road was built, abetted a movement to cut down the poles supporting the electric wires for the road, on the ground that the company was a trespasser. The

company secured an injunction, which was made perpetual by the Supreme Court. The principal point involved was as to the power of the city to permit the operation of cars by electricity. The court disposes of this by saying that it is a matter between the company and the State, and that the defendants are not in a position to raise the issue. The mere usurpation of corporate power does not confer upon the individual the right to bring suit to restrain the unlawful exercise of authority. If the State chooses to raise it, or by its silence permit the action, no others can complain so long as the personal or property rights of the individual are not invaded or affected. The opinion also holds that the use of streets for street railway purposes does not impose such new burdens and servitude additional to what was implied by the dedication that it is beyond the power of the city to authorize their construction without additional compensation to adjoining lot owners. The court holds, however, that the tracks cannot be constructed in a street too narrow to admit the passage of cars and other vehicles at the same time; that the road-bed and track must be built substantially with the level of the street, so as to permit vehicles to cross without difficulty, and that the poles must be placed so as not to interfere with the right of ingress and egress to abutting property.

PERSONALS.

Mr. Edwin T. Waters, of the Boston office of the Westinghouse Electric and Manufacturing Company, is in Pittsburgh, Pa.

Mr. J. McH. Reinhart, late district auditor of the Edison General Company, of New York, has been elected secretary and treasurer of the McClure Coke Company, of this city.

Mr. E. R. Gilman, president of the Great Western Electric Supply Company, of Chicago, Ill., and of the Northwest Thomson-Houston Company, of St. Paul, has engaged passage to Europe, and will shortly make an extended trip on the Continent.

Mr. William J. Cull, superintendent of the fire alarm telegraph office of Albany, N. Y., died last week of pneumonia, aged 59 years. He was well known throughout the country, and had been connected with the Albany department since 1868.

Mr. W. S. Turner, of the Woodbridge & Turner Engineering Company, of this city, was married on Tuesday, May 19, at Clarinda, Ia., to Miss Helen Sewall, of that place. Mr. Turner has been in business with J. Lester Woodbridge in this city since 1888. Previous to that time he was in the employ of the Edison Company, doing important work in the engineering department and in the installation of Edison central stations. In the last three years many large electric railway plants have been installed by Mr. Turner's company.

MISCELLANEOUS NOTES.

The Western Mineral Wool Company, of Cleveland, O., shipped nine million pounds of bulk wool last year. The company was organized in 1885, and during the first twelve months shipped 300,000 pounds of mineral wool. The management of the company is in the hands of Mr. C. H. Rockwell, of the Buckeye Electric Company.

The Phonodisk is the name of the latest mechanical telephone. This telephone, which is the invention of Mr. Henry B. Thompson, is manufactured in New York city and Pittsburgh, Pa., and is claimed to contain a diaphragm of great structural elasticity, which renders the system most efficient. Magneto call bells are used for signaling in long-distance lines.

Pittsburgh (Pa.) Electrical Exchange.—The electrical construction companies of Pittsburgh have organized an electrical exchange and elected the following officers: President, G. C. Vankirk; secretary, H. Robbins; treasurer, W. B. Aiken. The aim of this organization will be to secure a better class of work generally and a better class of men in the very important business carried on by electrical construction companies.

Industrial and Trade Notes.

The C. McIntire Company, of Newark, N. J., is rushed at present filling large orders for its wire connectors and with repair and other special work.

The Betts Machine Company, of Wilmington, Del., has recently shipped one of its large horizontal boring machines to the National Electric Manufacturing Company, of Eau Claire, Wis.

Mr. W. S. Chesley, of 135 Liberty street, New York city, sold during the last week 60 small motors. This speaks well for the energy of Mr. Chesley, and helps show how the field of application of electric power is growing.

The Mason Regulator Company, of Boston, is manufacturing the castings for the National Projectile Company at the special request of the Thomson Welding Company, whose managers are said to have stated that that company's castings were the best they had ever seen.

The Berlin Iron Bridge Company has issued a very beautiful catalogue and descriptive pamphlet of the many places equipped by this company. The book can only give a mere idea of the extent of the installations of the Berlin Company, which is celebrated throughout the country for its excellent iron work.

Aluminium Lamp Shades.—The Electrical Supply Company, of 171 Randolph street, Chicago, is manufacturing aluminium shades for use with incandescent lamps, which are remarkable for their beauty and neatness of design. This company is also bringing out a new fan motor, the fan blades of which are to be of aluminium.

The New York Electric Construction Company has opened offices at the New Electrical Exchange Building with stock rooms at 5 Broadway, and will push the sale of the Daimler motors, New York storage batteries and Colburn dynamo. Mr. J. H. Hapgood will be manager of the company.

The McIntire Manufacturing Company, of Newark, N. J., has within a short time brought out a line of single and double pole safety switches from 25 to 150 amperes, with slate bases, that have new and valuable features, and are sure to be in demand by the trade as soon as their merits are known.

Messrs. Sieb & Starke, manufacturers of electrical instruments, at 148th street, near Willis avenue, New York city are working day and night to fill their numerous large orders. They have recently shipped some of their goods to China, and word has been received that the goods are highly satisfactory.

Messrs. E. S. Ritchie & Sons, of Brookline and Boston, Mass., manufacturers of fine instruments, have issued a catalogue of electrical testing apparatus, all of their own manufacture. The book contains a most complete list of fine instruments of every description, besides an appendix devoted to the Ritchie fan and ventilating motors, etc.

The H. W. Johns Company, of New York, is introducing a new insulation called "Indurated Rubber," which is claimed to be an excellent article for trolley bells, lamp bases and sockets, bases for switchboards, rosettes, etc. Where good insulation is required not subject to a high heat, it is said to be waterproof and proof against the ordinary acids.

The Thomas Murray Company, which had the contract for the building of the Grand View Beach road, at Charlotte, N. Y., showed its engineering ability by the short time in which this rather long road was built. The contract provided that the road should be ready for operation on May 20, and the company had the road finished before that time.

The Hay-Horn Manufacturing Company, successors to the Walter Hay Manufacturing Company, of 63 South Canal street, Chicago, Ill., has issued its first catalogue and price-list for 1891. The pamphlet contains a complete list of electrical bell, telephone and battery outfits, besides a full stock-list of supplies, such as carbons, zincs, chemicals, cordage, wire, rheostats, etc., etc.

The Peckham Street-Car Wheel and Axle Company, of Kingston, N. Y., has recently received an order from the Syracuse Consolidated Railway Company, of Syracuse, N. Y., for 30 car trucks, and also orders from the following: Denver Tramway Company, of Denver, Colo.; Williamsport Passenger Railway Company, of Williamsport, Pa., and Butte Consolidated Railway Company, Butte City, Mont.

The Mason Battery and Electrical Company, of 257 Broadway, New York city, with a large factory in Brooklyn, N. Y., has been incorporated to exploit the patented inventions of James H. Mason. The company has recently issued a catalogue and price-list of its electric light and power battery plants, ranging in capacity from plants for 1 c. p. to 30 c. p. The catalogue also contains details of the Mason battery cells, fan motors, etc., etc.

The Conduit Wiring Company, of 12 West Twenty-ninth street, New York city, has recently been formed under the authority of the Interior Conduit and Insulation Company, to carry on a wiring business with the system of the latter company. This system comes well under the rules of the Board of Fire Underwriters, and no doubt the new company will be kept busy. At the office and show-rooms of this company is to be seen an interesting exhibit of the interior conduit system.

Alternating Current Fan Motors.—The alternating fan motor, which has just been placed on the market by the Emerson Electric Manufacturing Company, 513 Elm street, St. Louis, Mo., is giving excellent satisfaction wherever tried. Requiring but 1.$\frac{5}{10}$ ampères on a 52-volt circuit, the motor is but a trifle more expensive to operate than a 16-c. p. lamp, thus being one of the most economical motors on the market. The Emerson company is working the entire 24 hours in order to keep up with the orders, and has found it necessary to secure additional floor space for the various machine tools purchased.

The Illinois Electric Material Company, of 158 Fifth avenue, Chicago, Ill., Western agent of the Russell Electric Company, is meeting with success in the sale of the Russell arc lamp. As is well known, the Russell lamp is intended to take the place of the ordinary double-carbon lamp, and has a carbon disc in place of the ordinary positive pencils. The negative pencil is fixed in the bottom of the lamp frame the same as any ordinary negative pencil, while the disc is supported in the bifurcated end of the carbon rod, and is revolved by means of a rack cut in the hanger rod on one side and a pinion on the end of the disc carbon-holder. This revolution is very slow, an average of about once in an hour and three-quarters. The disc is easily removed for trimming, and the lamp requires less time to trim than a double-pencil lamp.

Mr. H. T. Paiste, of Philadelphia, Pa., the enterprising electrical specialty manufacturer, has opened a Chicago agency at 341 The Rookery, that city, where his western friends and patrons can be supplied without having to order from the factory in the East. The move seems a popular one among the supply men of the West, as it will save them the necessity of ordering in large quantities to save freight and express rates. Mr. Paiste still continues his Eastern office and factory at 1201 Market street, Philadelphia. The Western office will be managed by Messrs. Kohler Bros. and Grier, three enterprising young men, who will do all in their power to cater to the wants of the Western electrical trade in Mr. Paiste's line of specialties, which consists of porcelain base switches, china switches (which are decorated in all tints to match wall paper), sockets, cut-outs and gas attachments, etc., etc.

The Engineering Equipment Company has moved from its temporary quarters at 73 Cortlandt street, New York City, to attractive offices in the new Central Building, at 143 Liberty street. The company still retains the premises at 73 Cortlandt street for a stock of belting, wires, etc., which is carried for the convenience of customers who are not able to await shipments from the factories. It may be remembered that, as announced recently, Mr. F. L. Perrine is general manager, Mr. A. L. Tinker is secretary and treasurer, and Mr. F. A. Magee is electrician. Among the specialties which this company controls may be mentioned the following: The "Underwood cotton leather" belts and belting specialties, in which it has a large and growing trade; the well-known and first-class Anderson line materials, including the Boston trolley for electric roads; the Habirshaw wires, cables and cores, patent indurated fibre pipe, and the new "Kellogg" steel centre and side poles. The company is the sole agent for these poles.

Mr. Samuel T. Williams, of Baltimore, Md., manufacturer of the well-known Williams steam engines, reports having recently made the following sales: Baltimore Wire Nail and Screw Company, one 8-h. p. engine; Klinefelter & Co., one 8-h. p. engine; W. P. Harvey & Co., one 8-h. p. engine for the electric light plant, Baltimore, Md.; Wentworth Manufacturing Company, F. P. Robinson & Co., of Boston, Mass.; Edison United Manufacturing Company, of New York, one 12 h. p. engine; Surrey Lumber Company, of Surrey, Va., one 12-h. p. engine; Wenstrom Consolidated Dynamo and Motor Company, of Baltimore, Md., one 30-h. p. engine; Norfolk & Carolina Railroad Company, of Norfolk, Va., one 35-h. p. engine; Obermeyer & Liebmann, of Brooklyn, N. Y., one 5-h. p. engine; the Fred Hower Brewing Company, of Brooklyn, N. Y., two 18-h. p. engines. From some of the latter companies mentioned Mr. Williams has received some most flattering letters. The Williams engines are growing in favor with those who use them, some engineers reporting that "they have run as much as six weeks continuously, 12 hours each day, without putting a wrench on the engine, and this is not in a new engine, but in engines that have been in use two and three years."

The Pacific Electrical Storage Company, of San Francisco, Cal., has received the following commendatory letter for its apparatus, from Messrs. E. A. & J. O. Hayes, of Hillsdale, Cal.: "We wish to say that the accumulators and dynamo which you furnished us have been running nearly two months, and so far have been giving us entire satisfaction. The dynamo works very satisfactorily and the storage batteries have proved to be one of the greatest luxuries in connection with the house which we are just finishing. We only run the dynamo about twice a week and find the accummulators of very little trouble. They need practically no attention and furnish us with a very satisfactory light indeed. To have our lights always ready both night and day, without the necessity of running our dynamo, is a very great convenience. Although we have not yet run the plant long enough to ascertain the exact cost of maintaining and operating it, we are led to believe from our experience up to the present time that we shall be able to operate it very cheaply. Although we had some question in regard to the matter when we started, we are now satisfied that it is exactly what we want, and we shall be glad to furnish you with any facts in regard to the cost of its maintenance and operation later which we may have." The above plant was of 500-light capacity with 110 "15 L" accumulators.

The Huyette & Smith Manufacturing Company, of Detroit, Mich., makes a specialty of manufacturing the Smith ventilating fan, which has been indorsed by Westinghouse, Church, Kerr & Co. as follows: "The weak point of all ventilators is encountered when it is attempted to move air against any pressure, however slight. In such cases a portion of the air will slip back through the centre of the wheel, the area and amount of slip increasing with the increase of pressure. This result is expected when we consider that the thrust or propeling power of a screw fan (for such all these devices are) is greatest when (1st) the angle of the blade is the least, (2d) the velocity and area are the greatest. That is to say, the efficiency of such a wheel is greatest at its circumference, and reduces to nothing at the centre. If there were no back pressure, nearly the whole surface of the blade would act, but as pressure must always exist in some degree, there is always a portion of the wheel near the centre which cannot create a velocity equal to the resisting pressure, and as a consequence the air flows back through that portion of the wheel. As a consequence the wheel falls short of its capacity. The obvious remedy is to stop off the centre of the wheel by a plate, which is precisely the construction of the Smith wheel. The area stopped off is so proportioned that the wheel will blow without back lash. We assert that this is not possible with any other wheel. Constructively the centre plate adds to the strength of the wheel."

The Page Belting Company reports recent orders filled as follows: A complete outfit for the Beaumont Furniture and Art Wood Manufacturing Company, Beaumont, Tex., including a belt 20 inches wide; also an outfit of belting for the Mohawk Knitting Company's new mill at Mohawk, N. Y., and a large order of belting for the Pennsylvania Steel Company at Sparrow's Point, Md. Of the special belts of the Page make for running dynamos, shipments have been made during the last month to J. A. Grant & Co., Portland, Me.; National Sewer Company, Newport, O.: Forbes, Liddell & Co., Montgomery, Ala., and the Electric Forging Company, of Boston, Mass. Among the large main belts furnished have been belts to the Des Moines, Ia., Manufacturing and Supply Company; to the McNeil Pipe and Foundry Company, of Burlington, N. J., and to Gaines & Glover, Richmond, Va. "Acme Link" belts have been sent out during the past month to the following: For the Catasauqua Electric Light and Power Company, of Catasauqua, Pa.; Edison Electric Illuminating Company, of Boston (10 belts in all), one 20 inches wide to Chicago, Ill., and one 96½ feet long, 24 inches wide, to the Electric Light and Power Company, at Ellenburg, Wash. This last large belt contained 70,000 links or separate pieces of leather. Another large electric plant fitted up by this company during the past month is the Hampton and Old Point Railway Company. Among the belts are two of their "Acme Link," 20 inches wide, and two of the Page "Eureka Dynamo" belts, 13 and 16 inches wide respectively.

Mr. M. T. Davidson, located at 43-53 Keap street, Brooklyn, N. Y., has a number of valuable testimonials accumulated through many years devoted to the manufacture of the very popular Davidson steam pump. Among the most interesting perhaps of these communications are some recent acquisitions from the electrical fraternity. C. J. Field, president and chief engineer of the Field Engineering Company, New York city, writes the manufacturer: "In reply to your inquiry as to our opinion of Davidson steam pumps, and our use of same, would say that during my experience in the last four years in electrical construction work, as chief engineer of the Edison United Company, and later as general manager of the Brooklyn Edison Company, and now in our present construction work, I have frequently used your pumps of different styles and classes; the largest ones were two compound boiler feed pumps of about 400 gallons capacity, which were installed in the Brooklyn Edison station. These and all others that we have used have always proved entirely satisfactory, working under high pressures, and give a regular and steady supply of feed, with often a very high lift in the suction." A communication from the Edison Electric Illuminating Company, of Brooklyn, N. Y., says: "We have three 8 × 7 × 14 × 12 compound pumping engines (Davidson) at our station, two of which we have used continually from Sept. 1, 1889. They have given every satisfaction." The Newport station of the Edison Illuminating Company states, in ordering a large single-cylinder Davidson pump for boiler-feed purposes, to take the place of two duplex pumps of another well-known manufacturer, "We have one of your No. 6 pumps and like them very much." The Edison Electric Illuminating Company, of Rochester, N. Y., in ordering recently two No. 5 Davidson pressure pumps, also takes occasion to speak of the good work obtained from a previous purchase of Davidson machinery.

Business Notice.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

Intelligent people, who are familiar with the respective advantages which are offered by the several competing railroad lines between Chicago, St. Louis and Kansas City, and who desire to travel with the utmost speed, safety and comfort, always take the popular and reliable Chicago & Alton Railroad between these points, and passengers going to or coming from the South, via St. Louis, or when going to or coming from the West, via Kansas City, should insist upon having tickets that read over the Chicago & Alton. It is the only road with three complete and elegantly equipped trains daily between Chicago and each of the points named, and no railroad managers in America have a more intelligent appreciation of the wants of the traveling public than do those of the famous Chicago & Alton. 2t

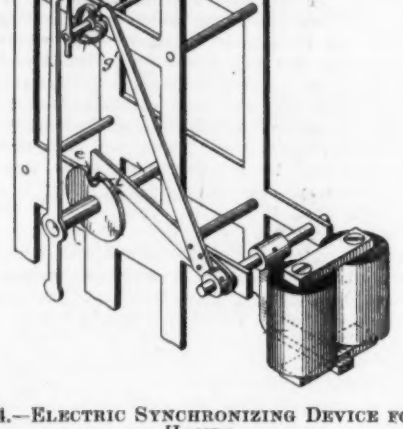
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENT ISSUED MAY 12, 1891.

452,341. Electric Cable; William A. Conner, of Pittsburgh, Pa., Assignor to the Standard Underground Cable Company, of same place. Application filed July 24, 1890. A series of two or more wires covered with fibrous material, closely laid wrapping surrounding said wires, said wrapping being omitted at suitable points along the length of the cable, sealing material surrounding the wrapping and impregnating and filling the core at the points of omission of the wrapping and a lead sheath, said sheath being compressed around the core where the same is impregnated with the sealing material.

U. S. PATENTS ISSUED MAY 19, 1891.

452,359. Electric Switching Apparatus; George T. Briggs, of Windsor, Conn. Application filed April 7, 1890. The invention consists of a make-and-break switch and a reversing switch mounted upon the same base, with a single operating



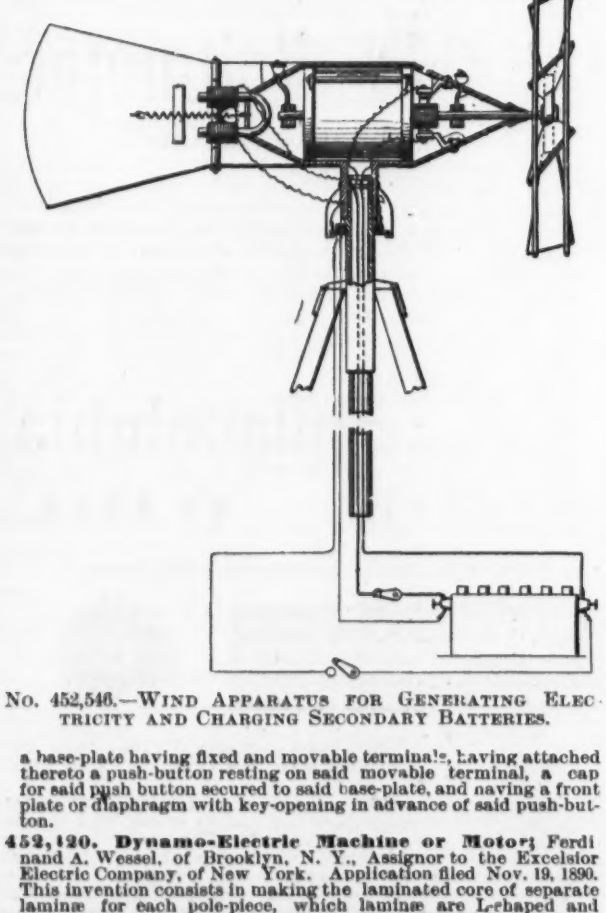
No. 452,424.—Electric Synchronizing Device for Clock Hands.

mechanism which operates both the make and-break and the reversing mechanism in one movement. The switch is ordinarily arranged so as to short-circuit the armature simultaneously with or immediately after the supply of current has been cut off from the armature. The field circuit, however, is left complete and active.

452,367. Electric-Light Fixture; John George Fischer, of East Saginaw, Mich. Application filed Sept. 8, 1890. The invention consists in combining with a cut-out conductors of fusible metal, which in the event of the conductors being short circuited or overloaded shall be instantaneously fused, thus breaking the circuit and avoiding damage.

452,392. Self-Winding Clock; Frederick M. Schmidt, of Brooklyn, N. Y. Application filed Nov. 25, 1890. The combination with a clock-train, an electromagnet, and a vibrating armature for winding the same; of a circuit controller, the movement or operation of which is dependent upon the movements of the armature, said circuit controller having contact surfaces or points adapted to be brought into engagement by the return of the armature to its limit of backward movement and maintained in such engagement during its complete forward movement.

452,397. Electric Push-Button; Max Straus, of Baltimore, Md. Application filed Oct. 4, 1890. In an electric push-button,



No. 452,546.—Wind Apparatus for Generating Electricity and Charging Secondary Batteries.

a base-plate having fixed and movable terminals, having attached thereto a push-button resting on said movable terminal, a cap for said push button secured to said base-plate, and having a front plate or diaphragm with key-opening in advance of said push-button.

452,420. Dynamo-Electric Machine or Motor; Ferdinand A. Wessel, of Brooklyn, N. Y., Assignor to the Excelsior Electric Company, of New York. Application filed Nov. 19, 1890. This invention consists in making the laminated core of separate laminæ for each pole-piece, which laminæ are L-shaped and counterparts of each other, and whose transverse legs are adapted to be piled one upon the other, so as to form the yoke or keeper of the field magnet.

452,422. Controlling Device for Electric Motors; Francis O. Blackwell, of New York, Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed July 13, 1889. The invention consists of an electric motor having a sectional field and a variable resistance, by both of which agencies the motor is regulated and a switch independent of the resistance-controller for cutting out or short-circuiting a section of the field.

452,423. Controlling Device for Electric Motors; Francis O. Blackwell, of New York, Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed July 13, 1889. The invention consists in a switch device which has a movement in either direction from a neutral or central position, and which when moved in one direction acts to throw the reverse switch and then cut out more or less of a resistance to control the action of the motor, and when moved in the opposite direction acts to throw the reverse switch to the opposite position and then cut out the resistance in the same manner.

452,424. Electric Synchronizing Device for Clock Hands; Albert M. Church, of Chicago, Ill. Application filed Nov. 18, 1889. The invention consists in an electromagnetic device adapted to be operated automatically to force a frictional wheel into a curved notch or seat provided in a disc or plate connected with the shaft of the minute hand of a clock to turn the minute hand backward or forward, if too fast or too slow to bring the minute hand to indicate the correct time, as shown upon the standard clock which operates the electromagnetic apparatus. (See illustration.)

452,429. Electric Motor; Elisha Gray, of Highland Park, Ill. Application filed July 3, 1888. The combination with an electromagnet of an armature for said magnet made in two parts, each part being flexible at two points, so that the parts may move to and from each other and to and from the magnet. (See illustration.)

452,494. Leading-in Wire for Incandescent Lamps; Reginald A. Fessenden, of Roseville, N. J. Application filed Feb. 18, 1891. A leading-in conductor for sealing in glass, consisting of silicon alloyed with a metal having a higher co-efficient of expansion and contraction than glass.

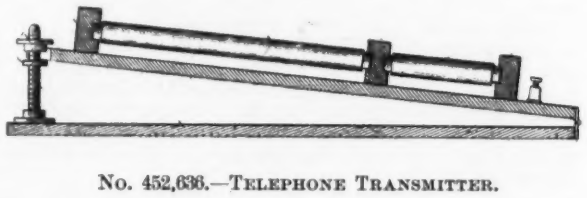
452,506. Electric Signal Apparatus for Fire-Hose; Jacon Fredrick Klumpp, Jr., of Louisville, Ky. Application filed May 17, 1890. The combination with fire-hose of a coupling device consisting of two hollow parts, each of which is provided with a tubular passage for wire, one of said two parts being provided with a curved or annular groove, in which is seated a curved metallic piece, a section of wire connected with said curved metallic piece and extending through one part of the coupling, and another section of wire extended through the opposite part of the coupling and provided with a spring pin.

452,510. Insulated Electric Conductor; Jas. B. Williams, of Oakland, Cal. Application filed Nov. 12, 1890. An electric conductor provided with a surrounding dielectric and an intermediate separating device, whereby air spaces are formed between them, and whereby the raised portions of said intermediate separating device are re-enforced on their under side, whereby they are prevented from being flattened against the conductor by external pressure.

452,515. Electric Railway-Train Signal and Recorder; Frd. H. Brown, of Chicago, Ill. Application filed Dec. 3, 1890. The combination of a primary electric circuit, a track contact included in said circuit, a circuit-closer carried by a train or other moving body, a signal device included in a shunt circuit, a resistance included in the ground connection of the primary circuit, and a battery of sufficient tension to overcome the resistance and shunt the signaling device into the primary circuit.

452,516. Joint for Electric Conductors; Edward Carroll and Thos. B. Lambert, of Chicago, Ill. Application filed Nov. 18, 1890. In an electric-conductor joint, the combination of a block of insulating material, containing a chamber opening at a side of the block, contact heads in the chamber, a contact removably inserted into the chamber between the said heads, and conductors entering the chamber from different sides of the block and engaging the contact heads to maintain them apart, and to the outer ends of which the severed ends of the conductors are to be secured.

452,523. Electric Insulator; Byron Jennings, of San Jose, Assignor of one-half to James Brusie, of Oakland, Cal. Application filed Sept. 12, 1890. In an insulating and suspending device for the conducting wires of electric railways, a two-part ear or



No. 452,636.—Telephone Transmitter.

bail channeled to receive and clamp the wire and having a ring formed in two parts, one of which is attached to each part of the clamp, said ring inclosing the insulator through which the suspending wire passes.

452,542. Trolley Device for Electric Railways; David N. Cook, of Salem, Mass. Application filed July 18, 1890. In a trolley device, the combination with a trolley lever of a bearing piece having in its upper end a vertical cylindrical bore containing anti-friction balls or rollers, the vertical axially rotating trolley spindle arranged in said bore, resting on the balls or rollers and provided with the rotating trolley roller and the cap, engaging the bearing-piece and retaining the trolley spindle in position.

452,546. Wind Apparatus for Generating Electricity and Charging Secondary Batteries; James M. Mitchell, of Lawrenceville, Assignor of one-half to Wm. A. Camp, of Greenway, Ga. Application filed Dec. 15, 1890. In a mechanism for generating electricity, the combination with a dynamo of a wind-wheel shaft carrying the armature of the dynamo, a pivoted support for said parts, a storage or secondary battery, conductors connecting the brushes of the dynamo to the poles of the storage battery, and means whereby the wind-wheel shall be presented to the action of shifting air-currents without interrupting the current. (See illustration.)

452,561. Brush-Holder for Commutators; Isaac H. Bartholomew, of Northford, Conn. Application filed Jan. 19, 1891. The invention consists of a spring-actuated brush carrier loosely mounted upon a horizontal shaft, a bearing piece frictionally mounted upon the said shaft and forming a stop for the carrier, and a stop rigidly secured to the shaft and arranged to limit the forward rotation of the bearing-piece thereupon.

452,565. Glass-Covered Electric Wire; William Curry, of Baltimore, Md. Application filed March 5, 1891. The invention consists in completely covering the wires with glass applied in tubular sections fitting up to each other, and each section comprising two parts or halves fitting together, one on each side of the electric wire and bound together by a small flexible wire which is wholly contained within a groove encircling the tubular section.

452,571. Electric Device for Harness; Albert B. Holson, of Chicago, Ill., Assignor of thirty-seven fiftieths to Robt. J. Zorge and S. Whipple Gehr, both of same place. Application filed Oct. 6, 1890. In an electrical device for harness the combination of a battery, an induction coil, sockets, wires extending from the induction coil thereto, plugs fitting the sockets, plates secured in the harness and resting upon the animal carrying the harness, wires extending from the plugs to such plates, and a push-button interposed in one of the wires between the battery and the plates, whereby upon actuating the push-button an electrical circuit is formed, the body of the animal upon which the harness is placed forming a part of such circuit, and an electrical shock thereby given the animal.

452,574. Rheostat; Chas. D. Jenney, of Indianapolis, Ind., Assignor to the Jenney Electric Motor Co., of same place. Application filed June 14, 1890. In a rheostat, the back and front plates of the frame, insulating-strips secured to said front and back-plates, at the top and bottom a series of bars mounted thereon, and resistance coils connected to said bars.

452,576. Crossing for Overhead Trolley-Wires; John Kuehnle, of Detroit, Mich. Application filed Jan. 2, 1891. The invention consists of two trolley-wires crossing each other, a metallic spider having arms the outer ends of which engage with the trolley-wires and the inner ends of which are scored to form passages for the trolley-flanges, a central hub adapted to engage between the flanges of the trolley, and a metallic bearing over the passages flush with the flange of the trolley.

452,585. Annunciator Drop; Howard C. Shivler, of Brooklyn, N. Y. Application filed Feb. 11, 1891. A sheet-metal annunciator drop, consisting of a substantially rectangular sheet of metal, having a shank pivoted to a support at one end, and having at the other end projections at right angles to said shank, lying in the same plane and extending in the opposite direction from each other, and bent inwardly toward said shank and upon the ends of a number-bearing card which lies flat upon said projection.

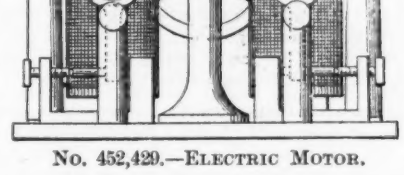
452,611. Conductors for Electric Railways; Edward W. Mitchell, of Spokane Falls, Washington, Assignor by direct and mesne assignments of one-fourth to Russell Parker, James H. Stearns and Benjamin F. Sutton, of Brooklyn, N. Y. Application filed Feb. 5, 1891. An electric conductor composed of sections hinged together and inclosed within an insulating tube or covering.

452,621. Motor Mounting of Electric Cars; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed Nov. 15, 1890. The combination, with a car, of an electric propelling motor comprising an axially mounted and directly connected armature and non-rotative field magnets mounted on a driving axle through springs independent of the mainspring of the car and roller bearings.

452,622. Electric Railway Car; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed Dec. 17, 1890. The combination, with a car, of a propelling motor having an armature surrounding the driving axle directly connected therewith by rigid arms and mounted in journal bearings formed in the yoke of the field magnets.

452,633. Electric Arc Lamp; Frank Buchanan, of Lima, O. Application filed Jan. 9, 1891. In an electric lamp the combination, with the carbon-holder, of a yoke-frame attached to the carbon-holder, a rotating friction-clutch wheel having its axle or shaft journaled upon the yoke and movable to and from the carbon, the shunt magnet having a longitudinally movable axial core and pawl-and-lever mechanism engaged with and positively moved by the longitudinally movable core of the shunt magnet to rotate the friction-clutch wheel in a direction to feed one carbon toward the opposite carbon.

452,636. Telephone Transmitter; Philip Fitzsimmons, of Birmingham, Ala., Assignor of one-half to Patrick H. Linnehan, of same place. Application filed Dec. 23, 1890. The combination, in



No. 452,429.—Electric Motor.

a telephone transmitter, of a board having a screw stem at its upper end, a board hinged to its end and provided with two or more carbon blocks, sustaining a loose carbon electrode and screw nuts arranged upon the stem upon opposite sides of the hinged board for adjusting the inclination of the latter and its electrodes. (See illustration.)

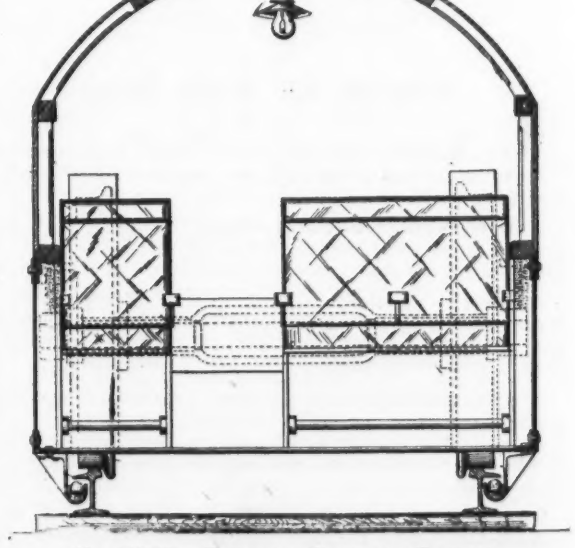
452,645. Insulator-Holder for Electric Railways; Byron Jenning, of San Jose, Assignor of one-half to James Brusie, of Oakland, Cal. Application filed Nov. 5, 1890. The invention consists of a protecting hood or cap, a means for supporting the conducting wire therefrom and providing an insulation between the two, and a means for supporting the hood or cap in an upright position when used on curves.

452,717. Electric Motor or Generator; Andrew L. Riker, of New York. Application filed Feb. 18, 1891. In a dynamo or motor, a continuous magnetic frame for the field magnet, built up of interlocking sections connected at their ends by a single bolt, each section composed of a series of blanks all of the same pattern, and each blank comprising an inwardly projecting core with an inclosed coil space on each side thereof and a polar extension on one side.

452,718. Bipolar Dynamo or Motor; Andrew L. Roker, of New York. Application filed Feb. 18, 1891. In a bipolar dynamo or motor, a field magnet having a continuous laminated frame composed of core sections and pole sections connected by lap joints, the core section and pole section being respectively composed of blanks, all of the same pattern, assembled together.

452,725. Insulated Electric Conductor; Jas. B. Williams, of Oakland, Cal. Application filed Nov. 12, 1890. The combination with an electric conductor and its surrounding insulating layer or dielectric of means having insulating properties interposed at intervals between the conductor and the insulating layer, whereby isolated or non-communicating air spaces are formed between the conductor and the insulating layer.

452,735. Electric Alarm; Chas. H. Shaffer, of Rockford, Ill., Assignor to the Electric Alarm Co., of Muskegon, Mich. Application filed May 5, 1890. In combination, a closed circuit, a portion of which is an alarm-circuit, a signal box in the main portion of the closed circuit, an electromagnet in the alarm-circuit preventing the starting of the box, and an electromagnet shunting the alarm-circuit, which starts the box when sufficiently ener-



No. 452,741.—Electric Railway System.

gized by breaking or increasing the resistance of the alarm-circuit, each of said electromagnets being of different resistance.

452,741. Electric Railway System; David G. Weems, of Baltimore, Md., Assignor to the Weems Electric Railway System, of West Virginia. Application filed March 13, 1890. In electric railway systems, a stationary axle or shaft, in combination with a sleeve mounted to revolve upon said axle and bearing wheels, and an armature fixed to and revolving with the sleeve. (See illustration.)

452,758. Microphone; August Carl Franz Müller, of Berlin, Germany, Assignor to Mix & Genest, of same place. Application filed May 31, 1889. In a microphone, the combination, with the diaphragm, a rolling electrode and suitable contacts, of a spring operating to hold the electrode to its contacts, and a sound-deadening material.

452,760. Composition of Matter for Insulating Purposes; Frederick Salanthé, of Jersey City, N. J., Assignor by mesne assignments to the Litho-carbon Company, of New York. Application filed Nov. 12, 1890. The invention comprises the combination, with a hydrocarbon product, of india-rubber, gutta-percha or oxidized linseed oil, in connection with sulphur.

452,765. Composition of Matter for Insulating Purposes; Frederick Salanthé, of Jersey City, N. J., Assignor to the Litho-carbon Company, of New York. Application filed April 22, 1891. The composition consists of a hydrocarbon product, gutta-percha and gum-shellac, in conjunction with which latter ingredient are also used small proportions of gum dammar or gum copal.